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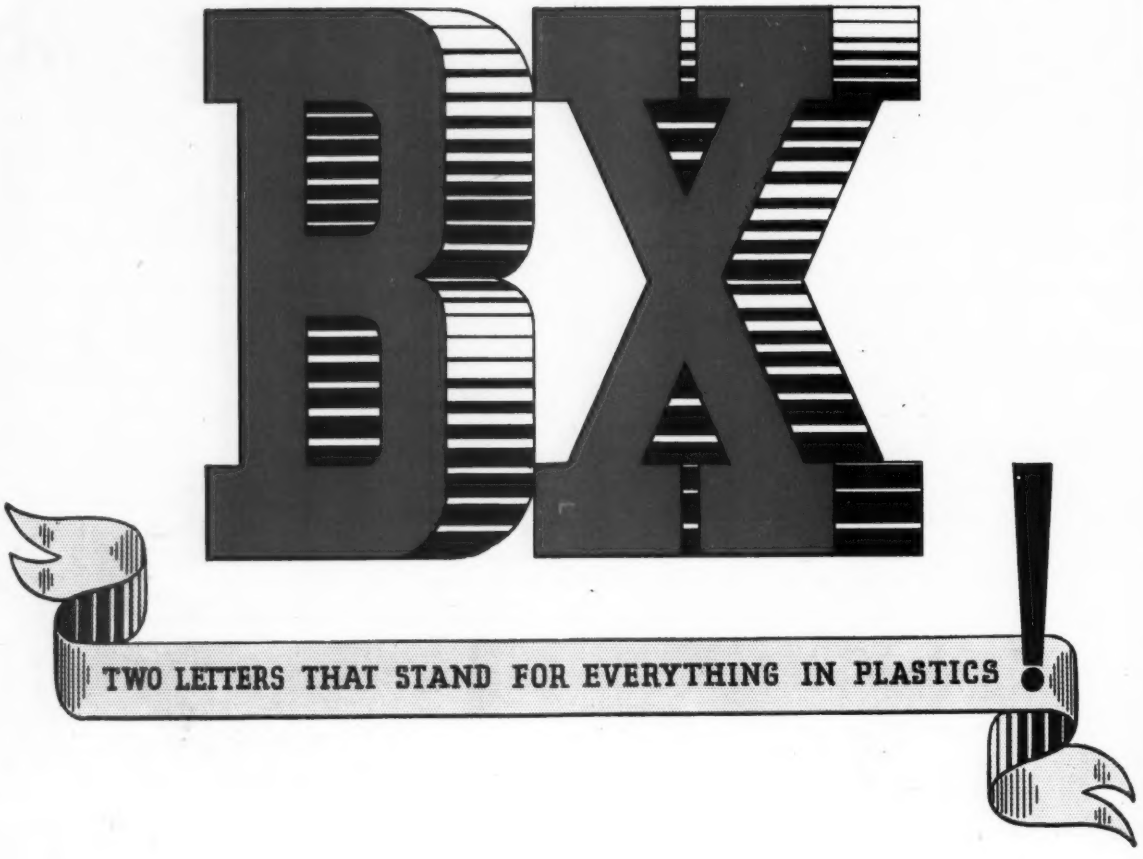


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# Plastics

Dealing with the Manufacture, Uses and Potentialities of Plastic Materials

Vol. IV JUNE, 1940 No. 37


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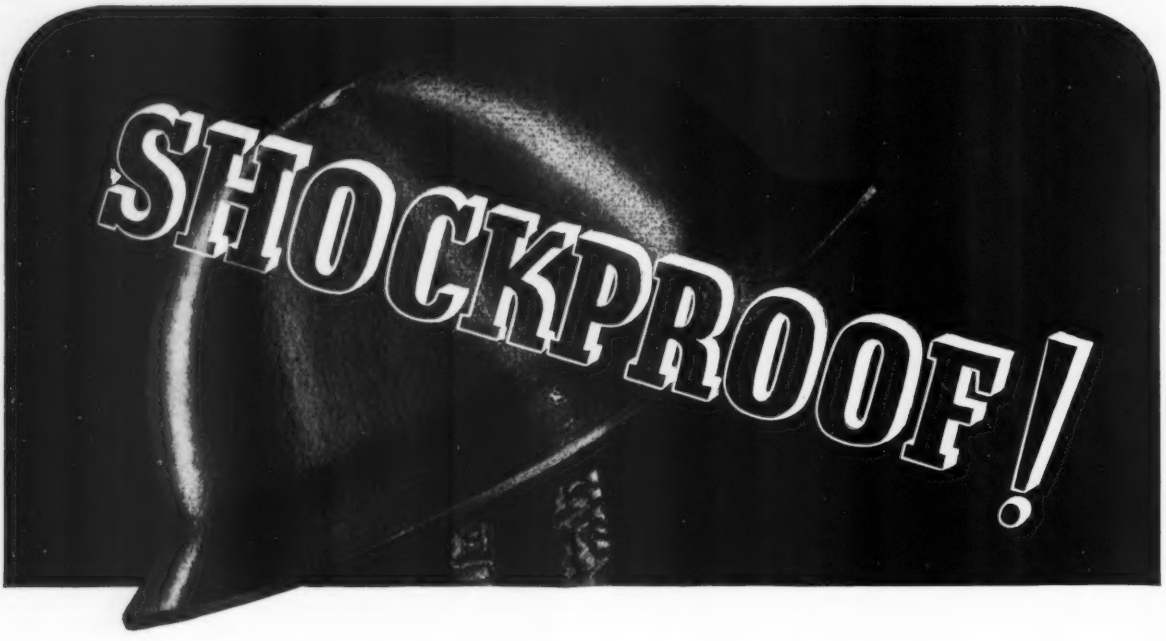


**Considerable attention has recently been focussed upon the possibility of moulding helmets from plastics for use by the Civil Defence Personnel employed in A.R.P. work. Helmets moulded from BAKELITE moulding material X.199 (patented) have been giving satisfactory service in South African gold mines for many years. They are strong, comparatively light in weight, do not corrode, are not affected by moisture, and are non-conductors of electricity.**

*The helmet illustrated is moulded by Messrs. Fraser & Glass Ltd., from BAKELITE moulding material X.199 (patented).*

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**THE MATERIAL OF INFINITE USES**

Vol. IV. No. 37 JUNE, 1940

# Plastics

*Dealing with the Manufacture, Uses and Potentialities of Plastic Materials*

Proprietors - - TEMPLE PRESS LIMITED
Managing Director - ROLAND E. DANGERFIELD

Editor - - M. D. CURWEN, B.Sc., A.I.C.
Offices - Bowling Green Lane, London, E.C.1

# EXPORTS

AS a result of the Government drive to extend our export trade, the British Plastics Federation has been in close touch with the Export Council of the Board of Trade since its formation early this year. The Chairman and the Secretary of the Federation have had several interviews with Sir Clive Baillieu, K.B.E., the Executive Member of the Export Council appointed to deal with the Plastics Industry.

As a result of meetings organized by the Federation, to which all interested manufacturers were invited, irrespective of whether or not they were members of the trade body, the following two Export Groups have been formed and given official recognition by the Export Council:—

**Moulding Powder Manufacturers' Export Group**

*Chairman:*
Kenneth M. Chance, Esq. (The Beetle Products Co., Ltd.).

*Members:*
Bakelite, Ltd.
Beetle Products Co., Ltd.
British Thomson-Houston Co., Ltd.
Birkbys, Ltd.
BX Plastics, Ltd.
Cellomold, Ltd.
Erinoid, Ltd.
Jas. Ferguson and Sons, Ltd.
I.C.I. (Plastics), Ltd.
Redmanol, Ltd.

*Secretary:*
G. T. Beach.

**Moulders' Export Group**

*Chairman:*
Herbert Bridge, Esq. (Thomas de la Rue and Co., Ltd.).

*Members:*
W. E. Amies, Ltd.
Armstrong Cork Co., Ltd.
Ashdowns, Ltd.
Barrett and Elers, Ltd.
Betts and Co., Ltd.
Birkbys, Ltd.
Bluemel Bros., Ltd.
Byson Appliance Co., Ltd.
Catalin, Ltd.
E. K. Cole, Ltd.
John Dale Metal Containers, Ltd.
Thomas de la Rue and Co., Ltd.
Derwent Plastic Mouldings, Ltd.
Ebonestos Industries, Ltd.
Halex, Ltd.
Hopf Products, Ltd.
Injection Moulders, Ltd.
Kork-N-Seal, Ltd.
London Moulders, Ltd.
Robert McArd and Co., Ltd.
Mundet Cork Products, Ltd.
N.B. Mouldings, Ltd.
J. S. Peress, Ltd.
Phipps Plastic Products, Ltd.
Prestware, Ltd.
Rosedale Associated Manufacturers, Ltd.
Souplex, Ltd.
Stadium, Ltd.
Streetly Manufacturing Co., Ltd.
Universal Metal Products, Ltd.
Viscose Development Co., Ltd.

It will be seen from the above lists that practically all the moulding powder manufacturers in the country have become members of their group, and to date 31 moulders are members of the moulders' export group. As regards the latter, a membership of 31 may not appear at first sight to be a satisfactory proportion out of some 150 to 200 moulding concerns in the country, but closer examination reveals the fact that, first, most of the large concerns are represented in the 31 members, and, secondly, that many others are simply not members because they are so full of Government work that they cannot possibly take part in export trade.

It is, however, of paramount importance that the membership be increased to embrace every plastic factory in the country, even though for some export trade is out of the question. Frankly, much money will be necessary to make a strong drive, and the initial fee of 3 guineas will obviously have to be considerably augmented. We should like to see even those who cannot partake in export trade supporting this very important movement. The repercussions of a really united effort should have great effect on the future strength of the industry, especially since, if we read the signs aright, such united strength will soon be called upon for other co-operative work in addition to the furtherance of export trade.

The appeal by the Federation stressed the fact that membership was open to all interested manufacturers,

irrespective of whether they were members of the Federation. We should like to add our voice to this appeal and urge all, large and small, to join in the effort.

The Chairman of the Moulders' Export Group, Mr. H. Bridge, has already made the suggestion that a compilation of moulds owned by moulders that would be available for producing export goods should be made, and eventually that a catalogue of such goods should be published for appropriate distribution. This is the germ of an idea that may have a profound effect on our industry and one that is a corollary to good organization. It closely resembles the movement in America of the publication of the stock moulds in the industry, and, provided the scheme is carried out with fairness, can have no other effect than the creation of a more virile industry.

We should have liked to have heard the suggestion that the distributive work of the Export Groups should be carried out by a limited company specially formed to do this work, which will involve great labours and time that representatives of individual companies cannot hope to spare in these busy days. Whatever course is adopted, however, we are sure that real co-operation with the one end in view—the helping of the country in times of need—will lead to lasting benefit.

# How Many Presses?

SOME six months ago the work of the plastic moulding industry was in a somewhat confused condition. Many outside plastic consuming industries, such as motorcar and vacuum cleaner manufacture, etc., had almost ceased producing for public use and the moulding concerns connected with them suffered severely in proportion. Almost all normal buying dropped considerably and most moulders were affected to some extent. On the other hand, some had already accepted Government contracts, directly or indirectly, and in part a change-over from peace to war-time work was in evidence. Some, indeed, were soon full of war-time work, others were still full of peace-time work. Many others also had presses that were not working at all.

At the time we stated that everybody within the industry knew that there were more presses in the plastics industry than were necessary for the work in hand. This state of affairs had, indeed, existed before the war, and the waste of potential energy had been sapping the life's blood of the industry, for it led to the vicious circle of price-cutting and, indeed, often to insolvency.

We are now living in times when it should be considered a crime for a press to remain idle even for a single day.

Without wishing to enter here into the unprofitable process of making invidious comparisons between well-run and badly run concerns, it does now appear that there is a heaven-sent opportunity for future betterment. Many industrialists throughout the country have realized that plastics are, in many cases, substitutes for metals, wood and the older materials of construction. Some have been disappointed, obviously. Many more have been completely satisfied, and the turnover to plastics grows apace. It would seem that, under proper guidance, the plastics industry should have far more work than it has ever had. But proper guidance is necessary. Many months ago we stated that the industry should approach the Government and say: "We are a coherent industry and have so many presses and so much raw material. We can be organized to make an important contribution to the country's effort."

So far we do not believe anybody has precise figures of the number of moulders in the country, far less of the number of presses in existence. And yet these figures are essential.

The first Government step towards this end is at last indicated in a recent pronouncement that a census of men and machines is taking place. The primary object appears to be to ascertain the number of skilled workers who can be transferred and to ensure 100 per cent. utilization of machine tools. No doubt the first steps are to ensure more rapid production in the aircraft and other armament industries, and few will not admit that some such step should have been taken long ago. A first census which gave valuable information was made in the engineering and shipbuilding industry, and now, according to *The Daily Telegraph*, the census is to be extended to the following additional trades: explosives, chemicals, metal industries, electric cables and equipment, iron founding, vehicle building, paint and varnish manufacture, and scientific instrument production. In this way there will certainly be disclosed a large amount of manufacturing capacity that can help the armaments industry. No doubt this will include the plastics industry. Given the data and given the guidance, the plastics industry can not only help enormously in the armaments drive, but so correlate its efforts as to take care also of such non-war work as may be necessary for home needs and for exports.

There is another and very important aspect of such a census. We earnestly hope that the Government will then make an effort to eradicate the practice of "stealing" expert workers from factories by the offering of higher wages. Many in our own industry have suffered already from such methods and, indeed, workers have been taken away from moulders who are actually engaged in war work. It is a stupid and vicious act resulting from panic and should be stopped. The census should be used to guide the flow of workers into the most useful channels.

---

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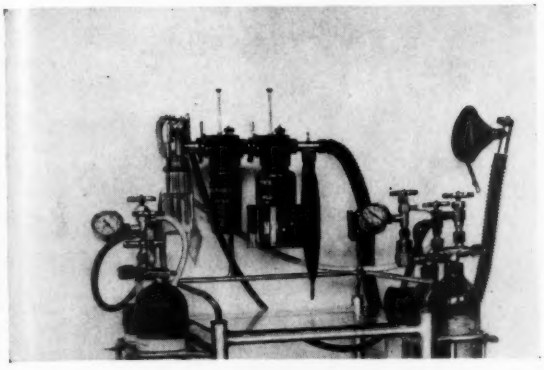
THE reduction in the supplies of raw material for newsprint to this country is so great that it is vital, in the national interest, that every effort be made to reduce consumption immediately.

In these circumstances, it is imperative that we restrict the number of copies we send to newsagents each month, and, in consequence, they will be unable to meet all their customers' requirements. You can greatly assist us in this national endeavour to save paper and shipping by passing on your copy to others interested.

From investigations conducted by us before the war, we know that *Plastics* was read by many more people than the actual number of copies sold, and in several instances it has been proved that a single copy changed hands week after week. If you are one of those who throw the copy away after reading, please do not do so in future, but pass it on to someone who may not otherwise be able to obtain it, or give it to your local public library. In any case, please pass your copy on and thus prevent wastage in the national interest.

If you will do this you will earn the thanks of the nation and of those enthusiasts who wish to keep in touch with the progress of events in the specialized subject covered by this journal, but have been unable to obtain a copy.

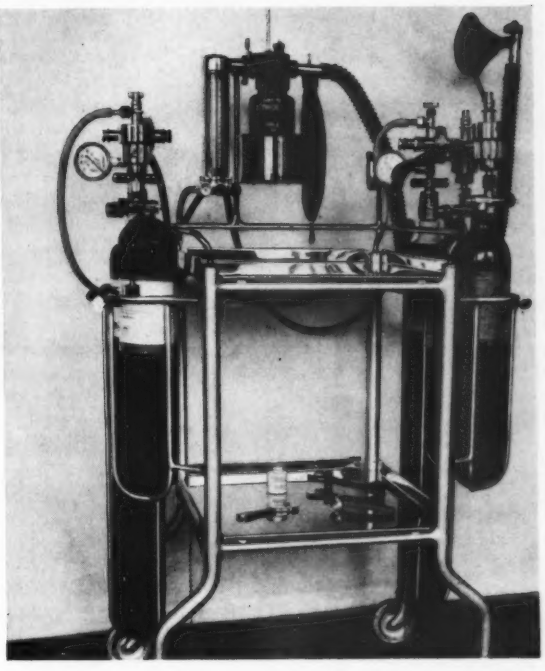


# PLASTICS IN ANÆSTHESIA

THE entry of plastics into an entirely new field is necessarily a slow process normally—one of careful examination and experiment by trial and error. So indeed should it be if we are to maintain the industry on a sure basis. That each new entry or attempt at such entry is of extreme importance and exciting interest to both plastic manufacturer and moulder, goes without saying, for each new use and even each new shape may teach us more about the materials we handle. Large or small, each object of plastics, if it is used under conditions that have never before been encountered, will give us more facts for future working.

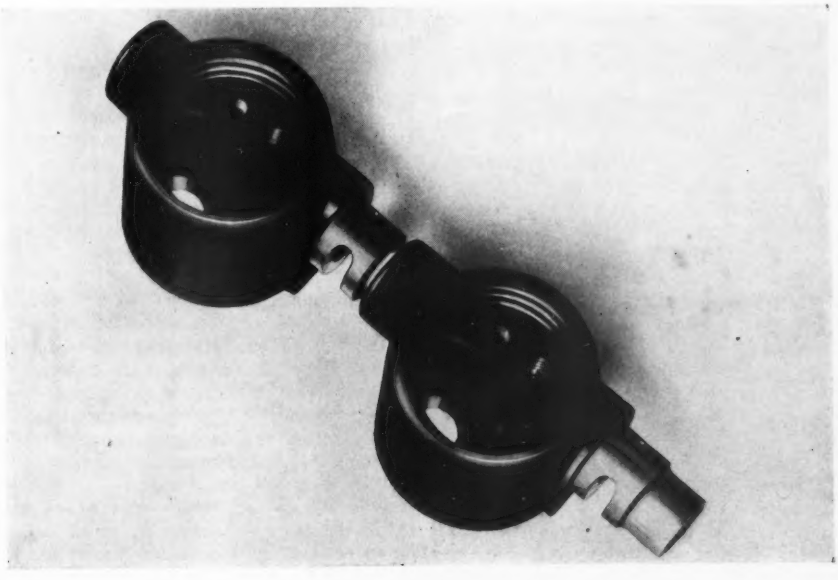
It was therefore with considerable pleasure that we recently encountered yet another such circumstance, in the field of anæsthesia.

About the middle of the 19th century, Coxeter and Son, Ltd., began the production of the early anæsthetics and the machinery for applying them. It is therefore in the forefront of the pioneers of this work and to-day its modern works on the Morden Factory Estate is famous throughout the world for the production of high purity anæsthetic gases and the high precision apparatuses used in administering them in surgical operations.



Examples of single and double bottle anæsthetic apparatuses made by Coxeter and Son, Ltd.

The combined anæsthetic apparatus shown in the above two photographs is patented by Coxeter and Son, Ltd., and consists essentially of a number of gas cylinders containing oxygen, carbon dioxide and nitrous oxide, which gases are allowed to pass at a controlled rate into chloroform or ether. On opening the cylinder valve the gas passes through a flow-meter tube, the rate being controlled here by a valve and indicated by a small light bobbin which rises or falls as the pressure increases or decreases. The top of the bobbin registers the rate of flow on a scale. Thence the gas passes to one or other of the bottles containing chloroform and ether. Here it bubbles through the liquid by means of tubes placed below the liquid level. The raising or lowering of these tubes allows for higher or lower con-



Close-up of anæsthetic bottle holders moulded by Moulded Products, Ltd., for Coxeter and Son, Ltd.

centrations as required. The loaded gases then pass through the gas bag and so to the breathing mouthpiece.

The most important plastic items in the apparatus are the chloroform and ether bottle holders. The history of their manufacture is interesting. When war broke out an urgent order was placed for many hundreds of these anæsthetic apparatuses, which, with the exception of the glass flow-meter and the rubber breathing attachments, were entirely of metal. It was immediately realized that the bottle holders, each involving the careful machining from solid metal, were an obvious danger point in rapid production and delivery would be slowed down to the speed of their manufacture. It was therefore determined to produce them in plastics, since once the mould was made production would proceed at a rate vastly greater than that possible when employing metal.

The work was entrusted to Moulded Products, Ltd., of Birmingham, with results that can only be described as eminently satisfactory, the finished units being made well within scheduled time. As will be seen from the enlarged view of the double-type bottle holder, the unit is quite complicated and is tubular in part to carry the gases through inlet and exit holes. Obviously, too, it is a precision job.

Although the number of these holders required is very small compared with the usual big runs encountered in the moulding industry, yet we have here a fine example of the value of plastics production when time is a vital factor. The requirements of Coxeter and Son, Ltd., could easily be supplied in one or two days from the time the mould was installed and tested in the press. Moreover, any subsequent and similar order would take the same time to execute. We can well imagine the length of time taken to produce, say, some 500 of the same units by the precision machining of metal at a time when the number of expert workers is so severely rationed. Moreover, it must be remembered that there is no increase in rate of production on the next order. This saving of time is rarely considered in assessing the value of plastics and the moulding industry. Would that the authorities could realize the potentialities of our industry from this point of view in a period when time is all important.

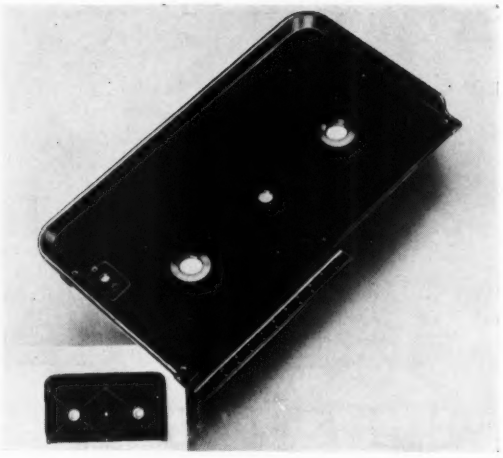


Table top (and back view) for anæsthetic set moulded by Moulded Products, Ltd.

In a similar apparatus produced by the same concern it is interesting to note the introduction of plastics in the flow-meter itself. In one type the flow tube, which is conical in shape, was originally of glass, but the difficulties of producing such a form in this material made the directors examine the possibilities of casting it from Perspex, the acrylic resin made by I.C.I. (Plastics), Ltd. This has now been done and has proved very successful. Incidentally, the bobbins in the flow-tube are cut from an extruded plastic rod.

Plastics have also entered into the construction of these anæsthetic apparatuses in the form of a table top for one special type. This top is shown in the accompanying photograph. It is some 24 ins. by 12 ins. and contains metal inserts and tapped holes for fitting on to the metal table.

# Resin-impregnated Plywood for Garages

RESIN-BONDED plywood for garage building is now being extensively used in America. There are two types of adhesives used for bonding this plywood. One is the sheet film type in which a cellulose material, such as paper or cloth, is saturated with the resin, partially cured or advanced and placed in sheet form between the veneers to be bonded. The other is what is called a colloidal type adhesive in which the bonding resin is in colloidal suspension in liquid form. The first basic patent on the use of this latter type was granted to the President of Durez Plastics and Chemicals several years ago. This type is claimed to be the more economical type to use because it can be applied in standard plywood glue-spreading machines. It permits a wider range of control in quantity required for specific grade of veneer and core.

The bond obtained by the use of resin is unaffected by heat, water, oil, mild acids and alkalis and atmospheric changes. Only fire will really destroy it. These are the reasons why phenolic resin-bonded plywood has been adopted by the American petrol service station builder. He has learned that in this type of plywood he secures all these attributes and more. He obtains a material that enables him to build faster, one that has excellent insulation properties, that will take curved shapes or can be curved to specific shape at the factory, permitting modern designs at a very small extra cost. In fact, these gas stations can be almost prefabricated. Saving more than one thousand dollars per station, erecting the stations at a rapid rate and being able to salvage much of the construction material when location changes are necessary, has interested many petrol and lubricating oil distributors. By using screws for attaching the plywood panels, both inside and out, more than fifty per cent. of the entire building material can be salvaged if traffic changes should demand its removal to another location.

The use of phenolic resin-bonded plywood for service stations does not end when exterior wall construction is completed. It is used for roofs and subfloors and even the cut-out sign letters. It has excellent rigidity and $\frac{5}{16}$-in. sheathing has been shown by the U.S. Forest Products Laboratory to be 5.9 times superior to horizontal lumber and 40 panels were all $\frac{3}{8}$-in. thickness. The interior is considerably better than diagonal sheathing or bracing. Phenolic resin-bonded plywood can be laid faster than conventional subflooring. It is far less likely to warp or shrink —which means less opportunity for annoying squeaks. Because the bond will not delaminate, cut-out signs and letters will be as enduring as the station itself.

# Furniture in Transparent Resin

IN a European world where manufacture, science and even art are orientated towards one end only, and where beauty is temporarily eclipsed and in shadow, it is pleasant to turn for momentary relief to those countries where the lighter side of manufacture still pursues the even tenor of its way.

When " acrylic " resin first burst upon a wondering world and was produced in bulk almost simultaneously in this country as Perspex, in the U.S.A. as Lucite and in Germany as Plexiglas, about 1935, its better-than-glass-like properties—its amazing powers of transmitting light and, compared with glass, its non-brittle nature—at once admitted it to the aircraft industry where, in sheet form, it could be shaped into windscreens, gun turrets and the other applications where transparency is essential.

Concurrently, there was some movement to make use of it as a material to be worked by the artist's hand and, since the resin can be handled or, rather, worked, as readily as ivory, many beautiful small objects were produced. It is interesting that these first efforts were nearly all carried out on the sheet and carving or turning were the general methods employed. Readers may remember the lovely trinket and similar plates carved by the late Lady Gertrude Crawford, and the beautiful examples of decorated sheet produced in France and in Germany which we have published from time to time in this journal. The most recent of these, which we saw at the Röhm and Haas stand at the 1939 Leipzig Fair, and which we reproduced on page 122 of our April, 1939, issue, was especially deserving of praise.

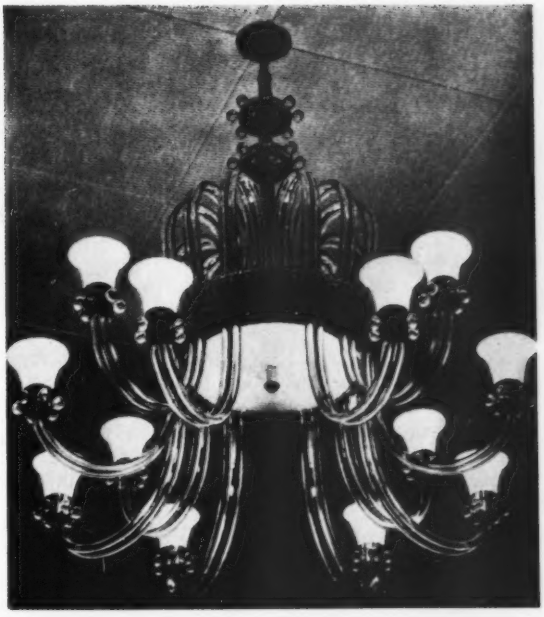
To-day the work of the artist has proceeded in yet another direction, for he has accepted the acrylic resins as a truly plastic material for shaping from the cast rod or tube. This artistry has, in the main, been applied to furniture, some of the earliest examples of which were seen at the 1938 Paris Fair.

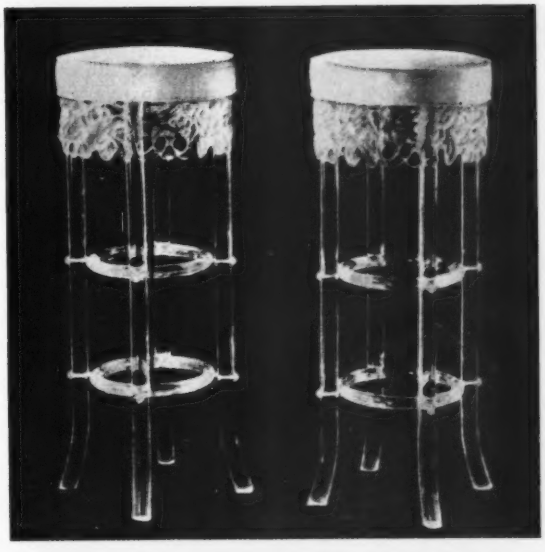
In the belligerent countries this work has almost entirely ceased, and we must turn to the United States for the most modern trends in this work, where the dilettante and connoisseur still have time to look on the beauty of the craftsman's work and, what is so important, can pay for it.

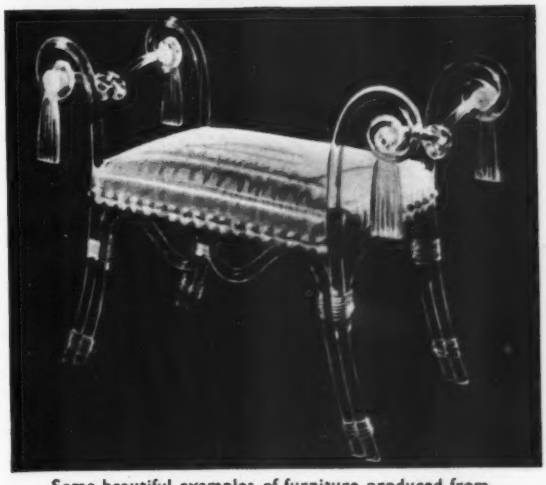
*Modern Plastics* of April, 1940, contains three photographs, herewith reproduced, of examples of applied art, made, for the most part, from cast rod fashioned into different forms. That they are completely new forms is not quite true. The chandelier is very little different in design from many others already existing. The bar stools are no different in outward shape than any other bar stools, while the other seat resembles closely the design we usually associate with the French Directoire period.

But what a difference there really is! The three examples seem to have emerged from the palace where Cinderella danced and, perchance, sipped a cocktail on the bar stool, with her glass slippers clinging to the transparent supports beneath. Transparency is indeed loveliness!

Acrylic resins are costly compared with the ordinary materials of furniture construction, and their fashioning is an artist's work for a very restricted market. So are most precious things for a restricted market, but so long as we are permitted to feast our eyes on them from time to time we shall be satisfied.







Some beautiful examples of furniture produced from Lucite and Plexiglas.

# American Plastics Industry, 1939

*In the February issue of "Chemical and Metallurgical Engineering" an excellent statistical review of the American plastics industry is given. The following is a brief synopsis of this article.*

PRODUCTION of cellulose plastic products last year showed increases in all lines over 1938, it has been reported by the Bureau of The Census. Production of nitrocellulose sheets totalled 9,551,548 lb. in 1939, compared with 6,616,787 lb. the previous year, an increase of 44 per cent. The rod production totalled 3,001,397 lb. last year, compared with 2,237,395 lb. in 1938, a 34 per cent. increase. A total of 820,227 lb. of nitrocellulose tubes was manufactured in 1939, which was an increase of 29 per cent. The reporting manufacturers consumed 3,476,226 lb. of nitrocellulose sheets, rods and tubes in their own plants during the past year, compared with 2,653,413 lb. in 1938. A total production of 9,140,907 lb. of cellulose acetate sheets, rods and tubes in 1939, compared with 6,830,506 lb. in 1938; an increase of 34 per cent. The cellulose acetate moulding compositions produced last year amounted to 11,654,928 lb., compared with 7,394,291 lb. in 1938, a 57 per cent. improvement. The current price of cellulose acetate moulding powder in granular form ranges between 52 and 46 cents per lb., according to colour and quantity. These prices represent a decrease of 3 cents a lb. in all quantity classifications, compared with the schedule previously in effect. The price of cellulose acetate butyrate in lots of 1,000 to 5,000 lb. is 44 cents to 46 cents per lb. and in lots of 5,000 lb. or more 43 cents to 45 cents per lb.

In the neighbourhood of 4,000,000 lb. of polystyrene resins were produced last year. The principal source of supply of raw materials is Dow, while the polystyrene resins are available from Bakelite Corp. and Monsanto Chemical Co. The coloured moulding resin sells on a made-to-order basis at 58 cents per lb.

Vinyl resins are produced by Carbide and Carbon Chemicals Corp., E. I. du Pont de Nemours and Co., and Shawinigan Resins Corp. (jointly owned subsidiary of Monsanto and Shawinigan Chemicals, Ltd.). Shawinigan Resins supplies Monsanto for its production of safety glass plastics and, in addition, markets vinyl resins for other uses. Prices of vinyl resins vary from 40 cents per lb. for polyvinyl acetate to $1 25 cents per lb. for polyvinyl butyral for making safety glass. Acrylic resins sell at, roughly, 85 cents a lb.

Phenolic resins were active in 1939. The moulding resins (including filler) produced approximately 54,000,000 lb. An additional 30,000,000 lb. of phenolic resins were used for impregnating and all other applications. The cast phenolic resin division of the industry made progress during the past year. Total production of cast phenolic resins in 1939 was about and possibly slightly beyond 6,000,000 lb.

Urea-formaldehyde resin production had a very successful year in 1939. The moulding composition produced amounted to 14,000,000 lb. Another million pounds of the solution of resin was used for lamination, cements, textiles and other applications. Prices for urea resins in granular form are from 27½ cents to 35 cents per lb. in quantity. The liquid resins sell at 22 cents to 24 cents per lb.

Lignin plastics made headway recently. Masonite Corp. was the first to enter the field, but recently the Marathon Chemical Co. has come into the market with a somewhat similar type of plastic. Marathon expects, ultimately, to offer lignin core and surface sheets for laminating, lignin moulding compositions for positive, injection and impact moulding and special lignin resins for coating, impregnating and adhesives. Of these the lignin laminating sheets are in commercial production and the moulding compositions and special resins are in semi-commercial production.

# Plastics in Building

IN an interesting article in the May issue of *The Builder*, Mr. R. Cotterell Butler, A.R.I.B.A., suggests possible uses of plastics as substitutes for timber and metal for non-structural building components. The author states that by pressing, extruding and moulding, products having such dissimilar characteristics as door furniture, panelling, pipes, tubing, conduit boxes and continuous open and closed sections, may be produced both in thermo-setting and thermo-plastic resins in a range of physical characteristics varying widely both in colour and mechanical properties. While it is safe to say that almost every non-structural building component may be produced by one plastic or another, the materials necessary for the production of plastics are hardly as ubiquitous as, say, clay or Portland cement aggregates. Dealing with suggested applications of plastics in war-time building practice, Mr. Cotterell Butler considers that they might be considered for the following purposes:—

Glazing framework generally. (Windows, roof lights.)
Fixed tables, benches, etc.
Cupboards, wardrobes, bookcases.
Shelves and draining boards.
Door frames, sills, doors, skirtings.
Architraves and cover fillets generally.
Curtain rails, pelmets, curtain tracks.
Rainwater fittings and water services.

These items represent a very formidable list and if plastics were used for all these applications there is no doubt that the industry would be kept busy for a long time to come. Our own doubt is whether, with the increased demand on plastics as substitutes for metal and wood in other vital war industries, there would be enough material available to satisfy the requirements of the building industry. There is also the question of economics. Plastics are not really cheap materials and laminated sheet, although undoubtedly superior in many important ways to wood, is a good deal more costly.

In view of the above hard facts, we think that before Government departments or other authorities recommend plastics as readily available substitutes for wood and metal they should first gather some facts regarding the ability of the plastic material manufacturers to supply the enormous bulk of thermo-setting and thermo-plastic resins needed to make good the ever-growing deficiency of wood and metal. The only satisfactory solution to the problem of limited supply and unlimited demand may be some kind of Government control designed to direct supplies into those channels best calculated to serve the national interests.

# PERSPEX FOR WAR-TIME DISPLAY STANDS

CONTRARY to popular belief, the display trade is by no means dead and plastics are now much in demand for various counter and window displays. The reason for this is patent to all. Metal, wood, cardboard, papier mâché and similar materials are becoming increasingly difficult to obtain and, in consequence, plastics, being the only suitable and available alternative materials, are now receiving close attention by practically all concerns catering for the display trade.

The work now being done by Efex, Ltd., Welwyn Garden City, Herts, in the development of plastic displays is of very great interest, because it is so closely linked up with the fabrication of acetate and Perspex aircraft components. This enterprising concern, which moved its factory from London at a particularly unpropitious moment, namely, August, 1939, switched over almost immediately to the production of aircraft accessories in plastics, and it is still very actively engaged in this work. Although for six months very little interest was shown by the trade in display items, development work was carried on steadily throughout that time and every effort made to interest the trade in plastic displays. As a direct result of its pioneer effort, Efex, Ltd., now report a greatly increased interest in various types of counter accessories, particularly displays for beauty preparations, hose and women's wear goods generally. This interest is being carefully fostered and a number of outstanding displays have been built up of Perspex and acetate. The latter material is being used to a very large extent, as it has been found that off-cuts and rejects from aircraft production are quite suitable for fabrication purposes, the highest optical properties not being absolutely essential.

The use of rejects from the aircraft industry for displays, signs and other purposes is of great interest. In the first place, off-cuts and rejects are very much cheaper than the best-quality material and, in the second, there is no fear of encroaching on fresh supplies vital to our aircraft industry. Although the production of display items may, quite rightly, be considered a purely luxury occupation, yet if it utilizes reject material unsuitable for aircraft work, and so prevents waste, then it serves a useful purpose and should be encouraged.

We have seen a large number of Perspex displays made by Efex, Ltd., some of which consist of simply formed sheets suitably ornamented and mounted on wooden or composition bases and others made up of blown pieces, cemented together. In all cases the advantages of this material for the purpose are obvious, and even when using reject material its amazing clarity

This attractive display stand depends for its striking effect on the formed Perspex sheet of amazing clarity.

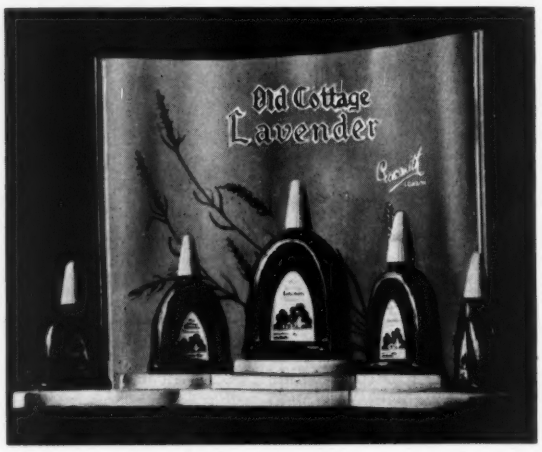
Here again Perspex sheet has been used with excellent effect and the stand is well designed to show off the products of this well-known house.

leaves nothing to be desired. It is useful to summarize quite briefly the advantages to be gained by the use of reject material.

1. The fabricator is able to produce a very attractive, and yet reasonably priced, display unit.
2. The manufacturer has at his disposal a display of outstanding sales-promoting value at a price which is really economic.

There is no doubt that once those manufacturers previously using large numbers of display items realize the present possibilities of plastics the demand will increase a hundredfold. In spite of all the trying conditions imposed on us by modern war, people are still buying and competition between branded goods continues unabated. It is being realized that war is no great leveller and that the best displayed and advertised goods still claim the highest proportion of sales. Trade in London may be lagging, but a visit to Coventry, Birmingham, Leicester, etc., will convince the sceptical that we are still very much a nation of shopkeepers.

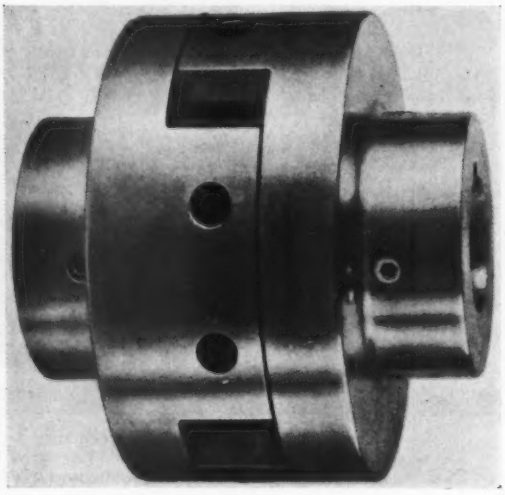
Novelty and serviceability are the main features of these two display stands fabricated of Perspex. The one on the left is designed to hold a single stocking folded to form the centre of a flower and tucked behind the transparent printed disc.




The back of this striking display stand for a well-known make of lavender water has been hand-painted with sprays of lavender to enhance the attractiveness of the display. The base of the stand is moulded of a special composition for which plastics are used.

## Laminated Plastics for New Coupling

A RECENT very interesting use of laminated plastics is found in a new flexible British-American coupling covered by British Patent No. 279,271. As in this coupling no flexible material and action are provided, the designation " compensating " would be a far better description of the action of this coupling. It utilizes the positive compensating action of the well-known Oldham coupling, which provides a means for equalizing radial and axial displacements of shaft ends. Between the two discs fixed on each shaft end and provided with rectangular slots a floating centre member is arranged, consisting of a square hollow casting. To the four edges are attached replaceable bearing strips of laminated plastic material. Owing to the excellent friction qualities and the effective lubrication provided, very low friction between central members and disc is present, thus lower power consumption and wear results. But even worn plates can be exchanged without dismantling the coupling. Only the fastening screws have to be removed through holes in the jaw giving access to the screwdriver; then the plates can be pushed outwards as the jaw length is smaller than the width of slot. In the same way the new plates are inserted and screwed on. The centre of the floating member is filled with a grease lubricant. Each bearing surface is provided with four small holes leading to the centre and wood reeds leading to felt pads in the special bearing strips. When the coupling revolves centrifugal force assists in the lubrication of the bearings.



## New Ideas in Collapsible Tubes

OWING to the scarcity of non-ferrous metals, particularly tin, in Germany, great strides have been made to utilize new organic flexible and non-flexible materials for the production of collapsible tubes used in the packaging of toilet and beauty preparations.

In a recent German Patent, No. 633,373, a cylindrical shell of a thermo-setting plastic material, such as phenol-formaldehyde or urea resin, is produced by moulding. The inside is provided with moulded-in threads and a threaded cap presses the contents through the opening in the head. In order to avoid a screw cap of great length, the latter is so shaped that it breaks off the rearward edge of the outer shell when the emptying process is carried out. Thus, the whole tube or shell gradually becomes shorter during use.

The main problems facing the production of collapsible tubes of flexible non-metallic materials are:—First, the actual manufacture of the flexible collapsible cover; second, connection of the cover with the tube head; and, third, means of closing the aperture when the tube is not in use. For flexible covers, such materials as viscose-cellulose, celluloid, latex and cellulose acetate are quite suitable.

# Plastic Novelties

*A selection of modern mouldings from the United States and also this country. Both thermo-setting and thermo-plastic materials are represented*

1

The Streetly Manufacturing Co., Ltd., is responsible for moulding this hygienic and yet attractive denture bath of white Beetle. It has been designed for appearance and continual usage.

2

This hose coupling for air-hose systems is moulded of Resinox phenol-formaldehyde resin by the Minneapolis Plastic Molding Co., of Minneapolis, U.S.A. Advantage of this coupling is that it is non-corrodible.

3

Two plastic materials combine their respective virtues to form this Horton Beer scraper-holder combination. The base is of Resinox, a tough durable phenolic moulding compound manufactured by Monsanto, and the holder and scraper are of polystyrene. The latter plastic, also made by Monsanto Chemical Co., is noted for its high resistance to moisture and alcohol. Polystyrol resin is being increasingly used in America.

4

In connecting this handy appliance plug to extension cables, no screwdrivers or tools are necessary. Ends of the two metal strands are pushed through the socket opening and placed on each side of the centre post. The separate disc is then twisted into place, firmly locking the wires in proper contact position. The plug is moulded of Resinox, a Monsanto phenol-formaldehyde resin possessing excellent electrical and mechanical properties.

5

A simple trick with transparent plastic enables purchasers of a well-known American finger-nail enamel to "try colours on" before buying. A ring of transparent cellulose acetate with a centre section die-cut in the shape of a portion of the nail which is normally covered with enamel is the device used. The nail-shaped section is actually coated with the enamel contained in the bottle. Shoppers slip their fingers through the ring in order to judge how the colours will appear on their own hands. This device is now in use in many beauty parlours.

6

A novelty in ashtrays, this moulded item is reversible. Universal Metal Products, Ltd., are the moulders in this case and the materials used are phenol-formaldehyde for the base and urea resin for the decorative white centre. Incidentally, this ashtray is reversible.

7

This package represents an excellent example of how to use modern packaging materials effectively for infants' wear items. The rigid transparent cover has been fabricated of Monsanto Vuepack (cellulose acetate). The base is, of course, made of cardboard.

# WORLD'S INDUSTRIAL

## AIRCRAFT

**New urea resin** specially designed to meet the conditions encountered in the aircraft and constructional woodworking industries just announced by British Industrial Plastics, Ltd., under the name of Beetle Cement A. Until the introduction of this new cement most synthetic resin cements depended for their success on close contact of the wooden surfaces to be joined. This close contact was essential and was obtained by accurate machining or by the application of sufficient pressure to force the surfaces together. In veneering, or plywood manufacture, these conditions present no serious difficulties, flat veneers being superimposed and the pack compressed between the broad flat plates of power presses. The natural compressibility of the wood serves to even out slight inaccuracies and variations in thickness. In constructional work and joinery, however, it often happens that rigid and massive sections of timber have to be assembled and glued together. Sawing, hand-planing and similar methods of carpentry obviously present considerable difficulties in obtaining perfectly flat even surfaces, and warping of beams is sometimes encountered. Hand-screws, jigs and cramps are often the only means of holding the component parts together during glueing. Thus there are encountered many practical difficulties in endeavouring to bring into regular and intimate contact the opposing surfaces to be joined. Research was therefore directed towards obtaining for constructional work a cement which would allow of the attainment of strong joints even where the wooden surfaces concerned are not firmly pressed together in absolute contact. This objective has been realized by the production of Beetle Cement A. Beetle Cement A is a cold-setting urea-formaldehyde cement which gives durable joints in constructional woodcraft and joinery. It fills the gap where close contact of the two surfaces of the wood cannot be made. Joints remain strong even where the cement-line is as thick as twenty thousandths of an inch. No pressure is required. It is sufficient that the cement should make good contact with the two wood surfaces, the joint being simply held firmly in position until the cement has hardened. Two hardeners are available: Hardener 15 for rapid working, and Hardener 50 for slow working. The former is suitable where spreading and assembly can be carried out quickly (the cement mixture remains usable for about one hour). Hardener 50 is used for large surfaces since it gives a cement mixture which remains usable for approximately twice as long. Overlap joints made with walnut specimens pass all the requirements of Air Ministry Specification D.T.D. 335. If the specimens are assembled with distance pieces so that the cement layer is twenty thousandths of an inch thick, shear tests averaging well over 1,100 lb. per square inch are still obtained on both wet and dry tests as is shown by the following figures (representing actual tests):—

**Dry**

| lb. per sq. in. | |
|---|---|
| 1,256 | ... Wood failure. |
| 1,443 | ... Glue and fibres. |
| 1,380 | ... ,, ,, ,, |
| 1,409 | lb. per sq. in. average. |

**After 24 Hours' Immersion in Water**

| lb. per sq. in. | |
|---|---|
| 1,558 | ... Wood and glue |
| 1,720 | ... ,, ,, ,, |
| 1,723 | ... Glue and fibres. |
| 1,675 | lb. per sq. in. average. |

Other interesting adhesives have been produced for cementing together mouldings (either urea or phenolic), for cementing mouldings to glass, metal, etc., and there appears to be no limit to the possibilities of these synthetic resin cements.

## ELECTRICAL

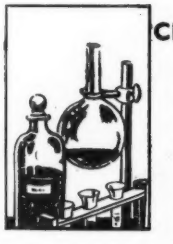
**Ersatz materials** now being extensively employed in German cable manufacture. One of the most vital and significant factors in the pre-war establishment of war-time economy in Germany was the Four Year Plan of national self-sufficiency in essential materials. Its ultimate effects cannot yet be estimated, but ever since its inception the plan has exerted enormous influence on what may be termed the "home technology" of German industry, innovations being introduced much more cautiously where exports were concerned. To the Nazi mind oil-less switchgear is quite as attractive by reason of its not requiring the use of imported oil, as on any other grounds, and now to oil-less switchgear there are added cables without rubber and lead as a means of substituting home-produced raw materials for economically—if not physically—unobtainable imports. A recent communication from the synthetic raw materials laboratory of the I.G. Farbenindustrie concern summarizes the results of extensive trials by the German Post Office, State Railway Company, and different industrial establishments, of various types of conductors and cables insulated and sheathed with polymerized products of the vinyl chloride type. While it is not yet possible to take cognizance of the new construction by the issue of special VDE-rules, the experience so far available indicates that cables without rubber, lead or copper will find permanent applications in many fields. Different compositions of the synthetic material are claimed to be suitable for the insulation or the mechanical sheathing of conductors, or both purposes, as the case may be. Troubles from decentralization of the conductors are apparently less likely than gradual hardening and embrittlement of the covering, but even if such ageing occurred it would not exclude the construction from all applications. Actually, the experience reported shows that under many conditions the synthetic insulation and sheathing are more durable than rubber and lead. Applications range from fixed connections on switchboards and the like to the wiring of buildings and the direct laying of cables in corrosive ground, but much more experience is required before the capabilities of the new materials can be fully determined.

## TEXTILES

**Chlorinated rubber** is now being used as a flame-proofing agent for textiles, according to an article in a recent issue of *The Textile Weekly*. In view, however, of the possibility of some decomposition occurring on prolonged exposure to sunlight and dampness, the risk of more or less serious tendering of fabrics cannot be entirely excluded. One method of avoiding this danger consists in blending the chlorinated hydrocarbon (rubber, paraffin wax, vinyl resin, etc.) with a water-insoluble salt which does not evolve oxygen when heated and is fusible at the combustion temperature of the treated fabric. Chemical satis-

# REMPLOYS PLASTICS

fying these requirements are certain insoluble salts of boric acid, such as manganese and zinc borates. Further protection of the chlorinated hydrocarbon against premature decomposition is provided by inclusion of pigments, such as iron oxide, etc. The proportion of proofing agent to fabric will vary with the type of fabric involved, according to the article. On cotton duck, for instance, it should preferably not exceed the weight of the cotton itself, but a larger proportion is permissible on more open fabrics. Satisfactory flame-proofing with retention of elasticity, strength and flexibility is said to be obtained when using proportions of ingredients ranging within the following limits (calculated upon the weight of the fabric); chlorinated hydrocarbon, 8 to 50 per cent.; borate, 1 to 30 per cent. and pigment 4 to 40 per cent.



## CHEMICAL

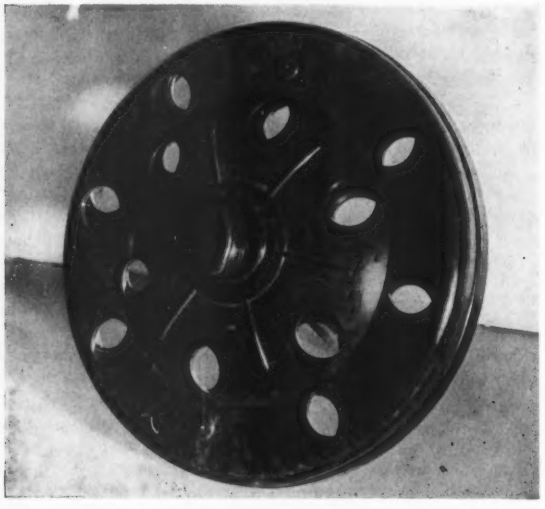
**A plastic joint seal** completely resistant to propane, pentane, butene, benzol, gasoline, naphtha, grease and oils of all types has been developed by the Glyco Products Co., New York City. Called Glycoseal, the new material is flexible, leak-proof and non-cracking. It will not harden and joints may be broken easily without damaging the fittings, according to the company. It can be used on rubber, which it does not attack, as well as on all kinds of metal fittings. Its use in propane service, both liquid and gas, is pointed out as an example of its effectiveness under difficult conditions. **Ethyl cellulose** is most readily prepared from wood pulp or cotton linters by treating with alkali to form sodium cellulose, then with an alkylating agent such as ethyl chloride or ethyl sulphate to form ethyl cellulose, then distilling and washing to remove by-products. Cellulose consists of glucose residues, which each present three hydroxyl groups, one primary and two secondary alcohol types, where substitution may take place. The ethyl cellulose of commerce has approximately 2.2 to 2.6 of these three hydroxyl groups substituted by ethyl groups. Substitution has a marked effect on softening point. In the range between 40 per cent. and 49 per cent. ethoxyl, ethyl cellulose is quite thermo-plastic, but the material has not been investigated much for thermo-plasticity. For use in lacquers 41 per cent.-43 per cent. ethoxy ethyl cellulose is available in various viscosities, the high viscosities being indicated where high flexibility and strength are of great importance. The properties of 47 per cent.-48 per cent. ethoxy ethyl cellulose illustrate the characteristic properties and its advantages over other cellulose derivatives. It is unusually flexible even at low temperatures, its extensibility being greater than all other cellulose derivatives, being as high as 40 per cent.-50 per cent. as a maximum and as low as 10 per cent. for the lowest viscosity type. It is stable to heat because of its high melting point (195 degrees-210 degrees C.) and has a low degree of flammability with no undesirable by-products of combustion. It is transparent to light and has a refractive index of 1.47 and is not discoloured by ultra-violet light. Also it is inert to alkalis, stable to dilute and weak acids, but has a moisture permeability a little higher than that of nitrocellulose, but somewhat lower than cellulose acetate. It possesses good electric properties such as low power factor and good dielectric strength. Its low specific gravity of 1.14 in contrast with 1.67 for nitrocellulose and 1.37 for cellulose acetate coupled with its greater spreading value gives about 45 per cent. greater coverage than nitrocellulose and about 25 per cent. more than cellulose acetate. In studies made of the compatibility of ethyl cellulose, especially with materials used in compounding lacquers and varnishes, it was found that with waxes such as beeswax, Carnuba wax, Montan wax and paraffin, incompatibility is most pronounced with straight chain hydrocarbons. With drying oils the order of compatibility is linseed oil, soya bean and perilla oil, with tung and oiticica oils showing poorest compatability. Besides the drying oil, fatty acids, the phenolic resins and resins of high acidity, such as rosin, are active solvents for ethyl cellulose. A resin solvent can be augmented by introducing a small portion of drying oil fatty acids in place of a portion of the usual drying oils. The full paper was read by Wm. Koch before the Montreal Section of the Montreal Paint and Varnish Production Club on March 13, 1940.

**Properties of vinyl resins** given by S. D. Douglas in *Ind. Eng. Chem.*, March, 1940, p. 315. Resins prepared from mixtures of vinyl chloride and vinyl acetate are of value owing to the influence of the properties of both these compounds on the mixture. To obtain a satisfactory picture of these properties it is necessary to refer briefly to the individual characteristics of the acetate and chloride. Vinyl compound polymerization is a chain reaction in which a large number of molecules react in rapid sequence and is influenced by several factors, notably the concentration of catalyst and temperature. The properties of the finished resin are closely related to its molecular weight. Polyvinyl is very resistant to water and chemicals, but it softens so slowly that decomposition begins before it can be properly moulded. Its applications are mainly confined to uses where resistance to sunlight, oxidation and oils is desirable. These properties contrast with the acetate which softens at a low temperature and has relatively little resistance to water. Thus it would appear that a combination of the two types of resin would have valuable properties. However, they proved to be incompatible, and it was only after the discovery that they could usefully be combined by co-polymerization that satisfactory resins were prepared. Here, as with the individual vinyl polymers, the size of the molecule is governed by conditions at the instant of formation. The best manner of classifying resins of this nature is by their vinyl chloride content and average molecular weight. Generally speaking, an increase in molecular weight adds to the strength and toughness of the resin, but makes moulding and solution more difficult. The co-polymer resins have excellent strength and resistance to water, acids, alkalis and alcohol. Heat stabilizing is good and stabilizers can be incorporated to prevent darkening in colour. For surface coating a resin with a molecular weight between 8,500 and 9,500 containing 85 to 87 per cent. of vinyl chloride is regarded as most suitable. The best solvents to use are ketones, as these yield solutions of minimum viscosity. A resin with a somewhat higher molecular weight—9,500 to 10,500—has been developed for coating paper. It is possible to produce films by calendering with a thickness of 0.002 in. A similar resin is also used for gramophone records and floor tiles. A co-polymer resin has been developed to meet the requirements of injection moulding having a vinyl chloride content of 85 to 87 per cent. Heat stabilizers are incorporated in this material to overcome any tendency to decomposition. Generally speaking, this type of resin flows at a lower temperature than other similar materials, and this factor, combined with low specific heat, leads to a considerable saving of heat in the injection cycle. For moulding sheet resin, materials up to 90 per cent. of vinyl chloride are in use.

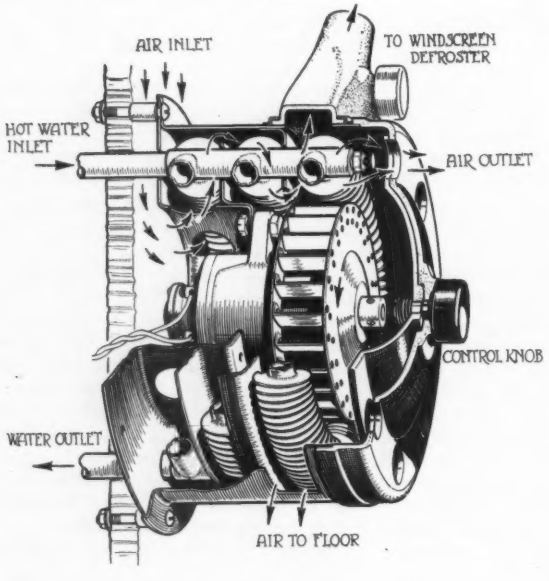
# MOULDINGS IN THE NEWS

## The Widney Car and Ambulance Heater

THE moulded air control forms part of a unit made by Messrs. Hallam Sleigh and Cheston, of Widney Works, Bagot Street, Birmingham, 4. It is designed to transfer heat from hot water to the air inside a motor vehicle, whether bus, coach, ambulance or private car. As to the source of heat, this may be the water of the normal engine cooling system or there may be a separate water circuit through a boiler heated by the exhaust gases of the engine. The latter is said to be the more satisfactory and boiler units for vertical or horizontal application have been developed. In the heater unit, metal construction is used except for the moulded cover and control. An electric motor drives an electric centrifugal fan of composite riveted construction, which might perhaps be replaced by a plastic moulding with some saving in cost, and possibly with advantage in the direction of silent operation. The heat transfer elements are of a cuprous metal which evidently has remarkable ductility. Finning of nearly three times the diameter of the tube itself is formed apparently by some sort of rolling process from the metal of the tube wall. This finning is helical and continuous along the length of each tube. Examination of the end of one of these radiator tubes suggests that the first stage is to form a spiral corrugation in the wall and that the high part of this formation is subsequently drawn, squeezed or rolled out to form a deep and remarkably uniform helical thread which is still part of the tube wall. Hot water is circulated through these tubes and air is drawn by the fan over and around the fins, from which heat is picked up and carried to the interior of the car. For that purpose, there are three outlets. Near the bottom of the casing there is a pair of ports from which hot air is discharged to the floor of the car. Near the top is another port with pipe connections to convey warmth to the windscreen so as to prevent the formation of mist or ice upon it. The third outlet consists of a series of holes in the plastic moulded cover, which permits the driver or passenger to adjust the volume of warm air delivered directly into the body of the vehicle.

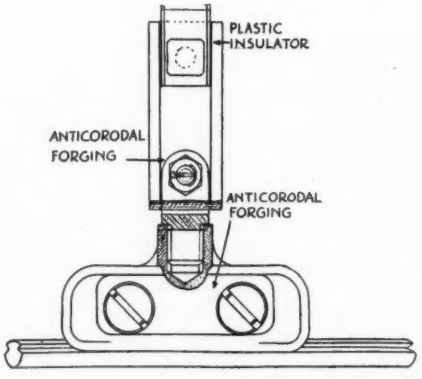


Above is a close-up of the moulded air control outlet and below a working drawing showing the complete mechanism of the heater.




## New Italian Use for Impregnated Wood

INTERESTING developments are taking place in the Italian plastics industry, where every effort is being made to develop its manufacturing capacity and to enlarge its scope in modern industry. Particularly interesting is the use which is being made of new aluminium alloys in conjunction with moulded and fabricated parts. Such combinations are finding increasing applications in the electrical and allied industries. From Turin comes news of one such application. This is a forged high strength corrosion resisting light alloy frog supporting specially profiled copper overhead trolley wires and marking junction of light alloy feed cable to the trolley wire. The plastic insulator consists of resin-impregnated wood similar to Durisol and Permali and possessing very high mechanical and dielectric strengths.




This line drawing gives a clear idea of the position of the plastic insulator. The frog is made of a new corrosion resisting alloy, and marks the junction between aluminium feed cable and specially profiled overhead trolley wire in copper, as used by Turin City Tramways.

# New G.E.C. Moulded Lampholder

THE principal feature of a moulded phenol-formaldehyde cordgrip lampholder (patent applied for) just introduced by The General Electric Co., Ltd., Magnet House, Kingsway, London, W.C.2, is that it eliminates the necessity of holding the cap of the lampholder when unscrewing the shade ring.

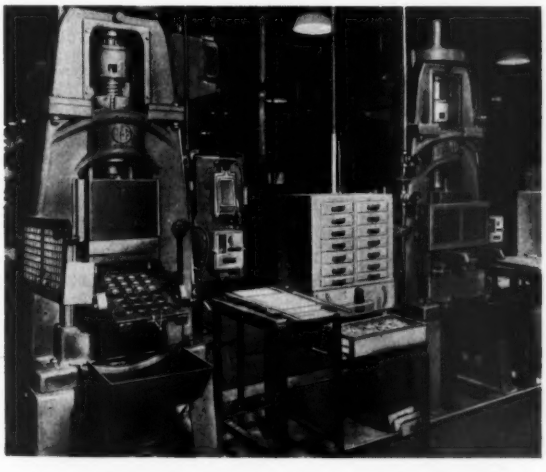
Previous attempts to meet this difficulty have been by the provision of a flange in the body at right angles to the axis of the holder, and immediately below the cap, but with this method it was found that when a shade was in position, it was almost an impossibility to grip this flange. In the new holder this drawback is overcome by providing two projections extending vertically from the flange outside the cap, and diametrically opposite to each other. The flange and projections are moulded integral with the body of the holder, and the projections provide a reliable grip. They can be held by one hand whilst the shade ring is removed by the other, and there is no tendency for the cap to be unscrewed during the operation.

This advantage in use has previously belonged only to the non-rotating cap-type of lampholder, which, on account of the more elaborate design necessary for purposes for which it is usually specified, is a more expensive accessory.

Other features of the lampholder are as follow:—(1) An alteration in the size and shape of the cap which gives it a more balanced shape and has made it possible to introduce the projections without substantially increasing the overall diameter of the holder; (2) a new shade ring of more pleasing appearance with a radius on the lower edge, so that for conical shades the ring can be reversed to fit snugly under the cone.

For the production of this new lampholder new moulds have been made and special 20-ton presses installed for the moulding of the caps and rings. These presses are of the electrically driven screw type developed by the G.E.C. Moulded Insulation Works at Witton. The press and tool combination is designed so that on opening the press the top tool impressions unscrew themselves out of the mouldings. By thus avoiding the necessity for removal of the moulds to the bench for unscrewing the threaded mouldings, the operating time is substantially reduced.

The G.E.C. anticipate a very good demand for this new lampholder once its several advantages have been recognized by the public.



Two of the electrically driven screw-type 20-ton presses installed specially for the moulding of the caps and rings of this new type of lampholder. The G.E.C. carry out all their own moulding at their modern works at Witton.

# A New Home Thermostat

GREAT as are its advantages, thermostatic control of domestic electric heating has not hitherto achieved the popularity it deserves. The reasons are not far to seek. In the first place, the public has not been fully informed on the subject; secondly, reliable thermostats, together with the necessary permanent wiring, involve capital expenditure often in excess of the cost of the electric heaters themselves. All this seems a pity, because it means that the consumer is not obtaining the maximum comfort from his installation and the electrical dealer is losing sales of thermostats.

It is, therefore, of great interest to consumer and dealer alike that the British Thermostat Co., Ltd., has developed and placed on the market at a very reasonable price a new home thermostat, suitable for controlling small and medium-sized electric fires, and arranged so that it may be easily and safely installed by the consumer himself. Sold under the trade name of "Adaptastat," the outfit consists of a simple yet robust bi-metal thermostat, wired to a series adapter which can be inserted in the same wall socket as the plug supplying the electric heater.

The housing is moulded of urea material and is a very clean and attractively designed production. Standard colours are cream, with the lettering picked out in gold and walnut, but a large number of other colours can be supplied to special order.

There is no doubt that the use of plastics for the housing will greatly increase its sales appeal, apart, of course, from affording a very high degree of insulation.

The thermostat, which has a good mechanical snap action, is rated to control up to 1 kw. at 100 to 125 volts or 1½ kw. at 200 to 250 volts. It is suitable for use on A.C. circuits only. An important feature of the "Adaptastat" is that it is portable, as portable as the electric fire itself, and can be carried from room to room with the fire. All that is necessary is to provide a nail or screw in each room for suspending the thermostat, and to plug in the adapter. A small adjusting knob permits a variation of the temperature setting to suit individual requirements, but the graduated scale is not calibrated in degrees. We understand, however, that the total range of adjustment is approximately from 40 degrees F. to 70 degrees F.

Close-up of the moulded thermostat which shows very clearly the clean and yet eminently practical design.

# METAL-SPRAYED COATINGS ON PLASTICS

By E. E. HALLS

PLASTICS, that is synthetic organic plastics, command a wide field in all senses. The variety of base materials offered, the range of forms in which each is available, the number of processes to which the majority can be subjected: these features all combine to force plastics into all conditions of service, those involving mechanical stresses, electrical rigours or purely decorative demands. Moreover, a unique feature of plastics, neither striven for nor claimed, is that they have established themselves upon their own merits, independent of other materials, and in most cases unchallenged by other commodities. Yet the plastics industry retains a broadminded outlook upon its industrial applications; it seizes opportunities to substitute plastics advantageously for metals; it supports all effort to complement metals with plastics in useful directions; but it does not, for example, advocate plastic panellings or mouldings where metal sheet or castings would be more serviceable. A broadminded and sympathetic viewpoint to the combination of metals and plastics is not therefore diametrically opposed to the general outlook of the industry, as some would suppose. An all-plastic article, direct from the mould or fashioned from sheet or other stock, always will be fundamentally the ideal and remain unsurpassed in perhaps the majority of applications. The combination of metals and plastics as far as inserts in mouldings (that is, fixing screws, electrical contacts and conducting wires, etc.) are concerned is a practice established beyond dispute. The inclusion of decorative inlays in sheet materials for wall panellings, furniture and the like is another field well exploited. Metal foil centrally inserted in laminated sheet for heat dissipation purposes is a newer yet useful practice. The idea of metallizing plastics by an additional operation of "metal finishing" may create the question "why?" but not only can the query be answered soundly, but, furthermore, it is stated that metallizing is a commercial fact.

Numerous processes of metallizing are available from which to choose the most appropriate. Vacuum cathode sputtering; vacuum evaporation; normal electro-plating; metallizing by spray gun: all these have possibilities, but the last of them is most universally applicable. Cathode sputtering relies upon transfer of metal from an electrode in a controlled vacuum to the article. Expensive equipment is involved, thick films require lengthy periods to build up, masking of areas not to be metallized is not easy, and in general a high degree of technical control is entailed. The same applies to vacuum evaporation, in which process the metal to be deposited is evaporated by electrical heaters in high vacuum. Electro-plating is a process more of a commercial nature, yet beset with difficulties by virtue of the non-conducting nature of plastics. Consequently, it is not surprising that metallizing by spray gun is the only mode extensively employed.

Several processes of metal spraying have been established commercially to a degree that enables unskilled operatives rapidly to acquire the technique required for their successful application. The first and most important of these is the wire process which uses a simply constructed and operated gun. In this, the metal in the form of wire is fed by means of a turbine through a nozzle and through the centre of a flame. The latter can use oxygen as one combustible gas, and hydrogen, coal gas or propane as the other. The flame melts the wire in its passage while compressed air, a by-pass from which operates the turbine and therefore rate of passage of the wire, atomizes the melted metal and propels it forward to the work, the gun being manually directed by the operator. This process can be employed with most metals that can be obtained in wire form, from the low melting point solders to metals as high melting as nickel (1,450 degrees C.). Despite the heat of the flame, operating conditions of distance of nozzle from work and rate of travel of gun across the work, are such that undue warming of the work with spoilage by distortion need not occur.

Another spray process uses metal powder, while a third actually employs molten metal. Limitations to the latter are those of constructing a gun to hold metal above its melting point, and zinc (419 degrees) is probably the highest melting element applicable in this way.

All spray metallization processes are similar in that work to be treated must be clean, and in particular free from oil or grease, which presents no difficulty in practice. Also, a "key" must be provided. The metal spray may be regarded as bombardment with rapidly cooling metal spheres in a plastic condition. Upon impingement of the solid surface they flatten, become saucer-shaped, and interlock among themselves. Upon smooth surfaces, there is nothing to which these particles can secure themselves, and in general it has been proved that roughening by abrasive blasting is essential. Sand or flint is best for this purpose, but crushed chilled iron shot is satisfactory and is usually employed because it avoids all silicosis problems. Adhesion is excellent and of a permanent nature.

Consequently, metallization involves several simple operations, all normal to general engineering industries, viz.:—

(a) Degreasing when necessary.
(b) Abrasive blasting in all cases.
(c) Metal spraying proper.

Further comments are warranted, however. First, abrasive blasting is recommended in all cases, but this may not be regarded by all technicians as true. Varnishing or lacquering are employed in certain cases with entire success. The limitations of this procedure can best be visualized by reference to a specific example, which, incidentally, involves a plastic but not an organic one. It concerns the glass bulbs of radio valves. In this case it is preferable and more economic to spray lacquer with a thin coating of cellulose, and then to apply the metal spray. It must be borne in mind, however, that adhesion in this case is assisted by the shrinkage of the metal film as a continuous band or envelope around the bulb, and in parallel cases it is likely to prove successful. Direct spraying on cellulose lacquered woodwork and on unglazed porcelain prove satisfactory. However, the writer has in no case met

with success by this method on flat metalwork, on general phenolic or amino mouldings, nor on laminated plastic sheet. For example, Bakelite laminated can be shot blasted and metal sprayed in sheet or strip, and then passed through press operations of blanking and piercing, and the spray coating on the components still retains its adhesion entirely unimpaired. If abrasive blasting is replaced by lacquering, the metal coating tends to laminate with the lacquer during the blanking operation. It is stressed, however, that this is only the present position of the art, and does not preclude the development of lacquers or varnishes appropriate to the need. Again, interested readers may wonder if plastic sheets mechanically roughed on sanding machines, or mouldings from sandblasted dies, present suitable surfaces; the writer has not found them to be successful.

Secondly, it is to be remembered that a metallized plastic can, within limits, be regarded as a metal. It can be polished by buff, chemically coloured or oxidized to china bronze, antique brass or silver finishes, or even electro-plated. Surfaces can be protected from atmospheric corrosion or from tarnish by handling by means of lacquer coatings.

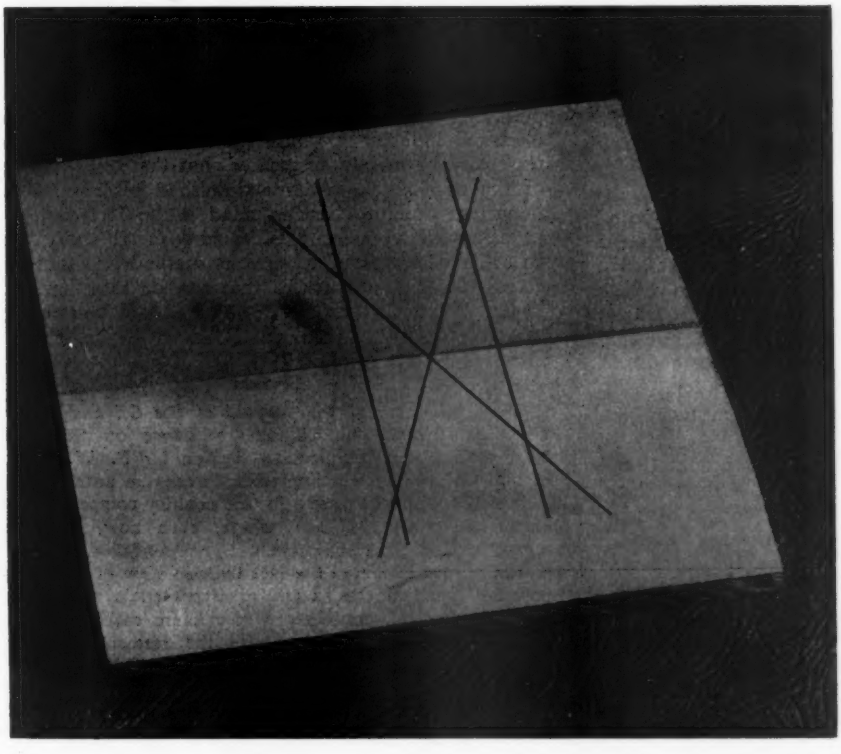
Metallized plastics are of real utility to electrical engineers. Items such as panels, boxes, chassis, etc., can be made of plastic for electrical insulation reasons with respect to mounting of apparatus, but may require metallizing wholly or in part for earthing, for magnetic screening, for high-frequency field or for X-ray shielding reasons. Zinc is suitable for the first of these requirements, brass or copper for the second, aluminium or copper for the third, and lead for the fourth. Areas not to be metallized can be shielded by the orthodox methods during spraying. Mouldings are often sprayed for electrical contact purposes, either rubbing or static pressure. Tin spray is used for this purpose. Again, the present possibilities are greater than hitherto. Many radio receivers and transmitters use aluminium in their construction for electrical design reasons, and the non-availability of light alloys means substituting brass. The additional weight of this is an important objection, particularly for semi-portable equipment. This disadvantage can be overcome to a considerable extent by adopting where necessary brass frameworks for mechanical strength reasons, and compensating the weight increase by using plastic laminated panellings, which are even lighter than aluminium alloys, and appropriately metal-spraying to secure the electrical earthing or shielding as required. It would seem that more serious attention is demanded to this development than so far has been paid to it. However, a warning must be given to electrical engineers—the electrical conductivity of the coating is much lower than that of a solid conductor of the same cross sectional area. This is due to the slightly lower density of the coating, which, in turn, is due to its mode of formation. For coatings of thickness of 0.004 in. to 0.006 in. in laminated sheet the following values are average recorded test figures:—

| | For Copper | For Aluminium |
|---|---|---|
| Density, per cent. of that of solid drawn metal ... ... | 56% | 58% |
| Electrical conductivity, per cent. of that of solid drawn high conductivity metal ... ... | 12% | 10% |

The density of the sprayed coating tends to improve as the thickness increases. This is important with lead coatings for X-ray protection, and the values given below are an interesting guide:—

| | Thickness of Lead-sprayed Coating | |
|---|---|---|
| | 0.005 in. | 0.010 in. |
| Density, per cent. of that of solid rolled sheet ... ... ... | 70% | 90% |

In connection with the possibility of replacing light alloy metal panels such as those of aluminium, aluminium silicon alloy, duralumin, etc., with metallized laminated resin, a number of samples were placed



This resin-impregnated laminated sheet has been metal sprayed with copper on the top half and zinc on the lower half. The lines shown are cuts made with a hardened steel conical rod. As seen there has been no flaking of metal under this test.

under durability tests in order to obtain some measure of deterioration, if any, in adhesion of the coating. The samples embraced panels of laminated, in thickness of $\frac{1}{16}$ in., $\frac{1}{8}$ in. and $\frac{1}{4}$ in. The qualities of laminated sheet covered normal good commercial materials, including electrical qualities to B.S.S. 316 and 547.

Preliminary surface preparation of these panels comprised degreasing in solvent naphtha to remove any traces of oil or grease, and then abrasive blasting by crushed steel shot in order to provide a key. It was found that without this roughening process the metal spray would not adhere.

The metals sprayed included copper to cover the higher melting point metals, and zinc to cover the lower or medium melting point ones. Actually, for convenience of testing all the panels were half sprayed with copper and half sprayed with zinc. These metals were sprayed by the wire process in the normal manner, using oxygen and hydrogen for the combustible gases, conditions of gas pressures, gun distance, etc., being those ordinarily employed when metal-spraying other materials, such as steel, etc. The thickness of metal coating applied in all cases was of the order of 0.005 in. The adhesion of the coating initially and at intermediate periods of the tests was checked by a scratch test. The requirements of this are as under:—

When the metal spray coating is cut through at normal atmospheric temperature to the base material by drawing hardened steel rod tapered to the frustum of a cone, conical angle 15 degrees, diameter of frustum $\frac{1}{16}$ in., vertically across the surface, the surface should reveal a clean cut, free from irregularities. When two such cuts are made crossing one another at an acute angle, the finish included in the angle should not flake or chip and should not be easily removable with the thumbnail.

From the attached photograph of one of the panels it can be seen from the scratch tests that the adhesion was quite satisfactory.

The durability tests to which the panels were exposed comprised the following:—

**No. 1. Hot and Cold, Wet and Dry Conditions**

In this the specimens were exposed to fluctuating conditions of temperature and humidity. The apparatus consisted of a metal-lined tank fitted with electrical heaters controlled by external variable resistances. In the base of the tank was a tray of water to provide for humidity, a fan achieving uniformity of atmosphere. The chamber was closed by a well-fitting lid. Specimens could be suspended from rods in the upper half of this cabinet. The temperature was controlled to 55-60 degrees C. during the day period, during which humidity was of the order of 70-75 per cent. During the night period the chamber was allowed to cool off to atmospheric and humidity rose to 100 per cent. with condensation upon the samples.

**No. 2. Salt Spray Test**

This comprised exposure to the mist produced by atomizing 20 per cent. salt solution at ordinary temperatures. The atomizer was arranged in the base of the cabinet and operated by feeding the salt solution by gravity to one orifice upon which impinged the second orifice fed with low-pressure compressed air. The mist produced rose through baffle plates into the cabinet in which they were suspended. A day's test period comprised eight hours with spray operating, the samples then being left in the chamber for the remainder of the day. They were washed with water and dried for examination daily.

**No. 3. Open Atmospheric Exposure**

Specimens were exposed freely suspended from a structure on a flat roof open to all weather conditions.

Under these tests the coated specimens were subjected to a range of moderate to severe service conditions. These included corrosive effect by moisture, industrial gases and saline solution or mist upon the coatings, this being accelerated by virtue of the bi-metallic contact of zinc with copper, as well as by differences in dimensional movement between the base material and the coatings.

Under Test No. 1 the coatings became badly stained during the first two weeks of test, but visually changed very little in the subsequent six months. Adhesion remained entirely unimpaired.

Under Test No. 2 the active corrosive nature of the salt atmosphere on the bi-metal coating caused zinc and copper to corrode. The copper initially darkened while the zinc became white. In nine days the copper had largely corroded away. In 14 days both coatings were mainly destroyed. This, however, was a matter of corrosion and by periodic testing no loss in adhesion as such was observed.

In test No. 3 some corrosion occurred during the first 10 days; the copper became whitish and the zinc darkened at the junction with the copper. Except for the development of a dirty appearance due to the accumulation of dust and dirt, no further visual change occurred in six months. Adhesion at the end of this period was entirely unimpaired.

From these admittedly severe tests it must be granted that metal spraying of the phenolic plastics is sound. The mechanical attachment of the coating afforded by abrasive blasting is sound and remains sound. The feature most logical to suspect as a potential source of failure is differential movement, either due to varying temperature coefficients of metal and resin sheet, or to shrinkage of the base material under dry conditions and expansion under moist conditions. The tests show that no such failure is likely to arise, and should therefore remove hesitancy from the minds of designers.

The practical illustrations above have referred to phenolic plastics and apply equally to the amino group. There are no limitations to the spray metallizing of the thermo-setting varieties. The applications in the electrical industry are utilitarian; in other directions they may be mainly decorative, but there is no doubt of the possibilities of "metal-finished plastics." An important point to bear in mind is the fact that the processes of abrasive blasting and metal spray can be achieved by barrel or tumbler methods, so that the artistic finishing of articles that can be mass-handled in this manner is possible.

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**Solvents**

The April issue of the *Journal of the Oil and Colour Chemists' Association* contains a paper on this subject, read before the Scottish Section by F. W. Clark, F.I.C. It is especially interesting, since the author deals with production of solvents in this country compared with the situation in 1914 and where, even now, we have lagged behind other countries.

The author lamented the fact that, in view of the many solvents, synthetic resins and other materials made from it, there was no manufacture of calcium carbide in this country. He described some of the fermentation processes necessary to produce solvents and gave the interesting fact that about four years ago the fermentation process for acetone and butyl alcohol was put into operation again in this country by Commercial Solvents.

# Ideas—

## By the EDITOR

**Picture Frames**

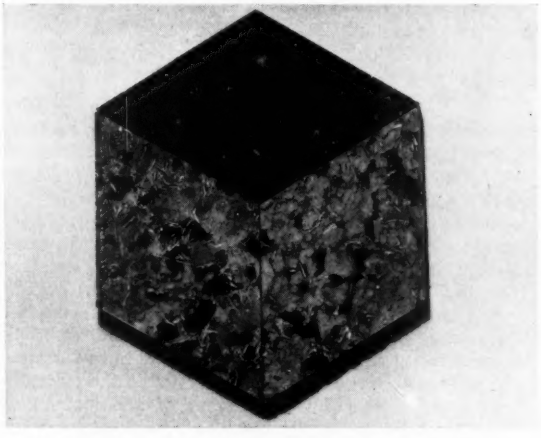
A reader asks whether I have ever encountered the suggestion that the simple type of picture frame should be made from extruded phenolic mouldings. I seem to remember this quite a long time ago. Theoretically, it is an attractive one, the frame maker simply sawing the length at any angle he requires. The method of holding the four pieces firmly together is, however, a difficulty; in default of a suitable glue it was originally suggested that a metallic angle fitted with a spring would serve. Economically, at least in peace-time, I believe the idea would not pay. Wooden frames are exceptionally cheap and, moreover, are surface moulded.

The plastic frame is common here and in the U.S.A., but is moulded as a whole. In the latter country, I believe they are now being produced from acetate by the injection process.

Extruded cellulose acetate would, because of the variety of colour, stand a better chance. But, here again, jointing would be difficult.

**Dance Floors of Orobello**

Last month we published some additional notes regarding Orobello, which I pronounced some time ago as a new application of the mosaic art. As we have already shown, table tops in the material are very beautiful, for Mr. de Faveri, the inventor and the craftsman, has introduced combinations of colours and metal effects with remarkable success. Orobello is not a laminated material, the sheet or table top being built



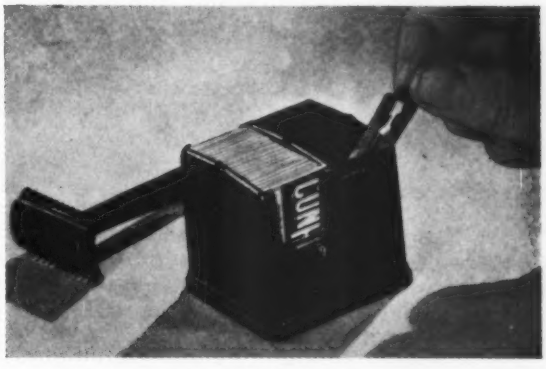
up from small pressed shapes. In the accompanying photograph the hexagon is made up from three parallelograms of ⅛-in. thickness. The top section is in black and green, and the two lower segments are in light and dark browns flecked with " gold " metal.

Mr. de Faveri hopes one day to make a dancing floor with Orobello, for he has great faith in its strength and wearing qualities. In passing, although the effect resembles a mottle, it is not the crude mottle of ordinary mouldings, but rather a mosaic within a mosaic.

**Razor Blade Cases**

I remember that during the last B.I.F. at Olympia I was approached by a member of a famous safety razor blade company regarding the possibilities of moulding a used razor blade container. Whether it is made of metal or plastics, the main difficulty is to design a box to prevent blades falling askew.

A recent issue of *Modern Packaging* describes a dual-use package moulded in Bakelite by Associated



Attleboro Manufacturers for the Conrad Razor Blade Co. Inc., U.S.A. One side holds 50 new razor blades and the other 200 used ones. From the theoretical point of view it is, of course, possible that 200 can be contained therein, but the photograph does not indicate that blocking does not occur.

**"Beetle Magazine"**

House magazines, those journals that cater only for the company's workers and customers, have an immense pull over the severely technical journals whose editors are generally restricted to " hard tack " and only rarely can give vent to humour or philosophy. Would that it were otherwise and that technical readers were more amenable to a lighter mixture. On the whole, readers of *Plastics* have put up with such rare fun or philosophy as I can squeeze in on this page, but the Editor of *Beetle Magazine* does it always, and I envy the idea. His Spring, 1940, edition contains a message for us all—words written by the German Dibelius in 1922.

" But the fact remains that Britain is the solitary Great Power which has never injured the vital interest of another European people by annexation, and it is a fact of immeasurable moral effect in a period dominated by the principle of nationality. . . . Britain is the single country in the world that, looking after its own interests with meticulous care, has at the same time something to give to others; the single country where patriotism does not represent a challenge to the rest of the world. . . . Britain is the solitary Great Power with a national programme which, egoistic through and through, promises at the same time to the world as a whole something which the world passionately desires—order, progress and eternal peace."

# Inquiries and Answers

*(In Which is Included General Correspondence)*

### Domestic Plastic Goods

2 and 3, Quadrant,
Lime Street,
Liverpool.

The Editor, *Plastics*.

Dear Sir,—As we are contemplating the sale of plastic articles through our retail department, we shall be glad if you will put us in touch with suppliers of domestic plastic goods.

D. C. HIGHAM,
Hellewell and Co. (Caoutchouc), Ltd.

[EDITOR'S NOTE.—Will those interested, please write direct?]

### Books

London, W.C.2.

The Editor, *Plastics*.

Dear Sir,—You very kindly published a note stating that I had been appointed instructor in Industrial Design at the Central School of Arts and Crafts, and I wonder if you could be so kind as to give me some advice.

I want to find out the names of some good text-books on plastics, both for elementary and advanced students, and would be grateful if you could let me know where I might obtain this information. I would also like to know if any courses in the purely engineering aspect of the plastic industry are held in any schools or other educational establishments.

MISHA BLACK.

[EDITOR'S NOTE.—The following are most of the available books on plastics, together with some comments:—

(1) Carleton Ellis's "Chemistry of Synthetic Resins," two volumes, published by Chapman and Hall, Ltd. The most complete scientific compilation of the subject, containing theoretical conceptions, manufacture, applications and, to some extent, compression working of plastics. On the whole, it may be that this work is too chemical for art schools.

(2) Bell's "The Making and Moulding of Plastics," published by Hutchinson. More "practical" than (1).

(3) Rowell's "Technology of Plastics," published by Plastics Press, Ltd. More "practical" than (1).

(4) Rahm's "Plastic Molding," published by McGraw Hill. More "practical" than (1).

(5) Brandenburger's "Processes and Machinery in the Plastics Industry," published by Pitman. Very practical, but limited to cold, hot and injection moulding. There is little or no description of the different plastics available or their properties.

(6) Simonds's "Industrial Plastics," published by Pitman. See our review in April issue.

Unfortunately there appears to be no book which deals adequately with what should be most important to an arts and crafts school, namely, the working of casein, cellulose acetate sheet, cast acrylic resin and sheet and cast phenolic resins. We should advise the inquirer to get into touch with BX Plastics, Ltd., and Erinoid, Ltd., for information on casein. The former publishes some excellent practical pamphlets on the working of acetate sheet. I.C.I., Ltd., have good literature on machining and working of cast and sheet Perspex and Catalin, Ltd., on their cast resin. Catalin, Ltd., should also have information on the casting of liquid resin into prepared moulds. This practical information rarely finds its way into textbooks. Courses in plastics are held at The Borough Polytechnic, London, S.E.; Northern Polytechnic, London; S.W. Essex Technical College, Walthamstow; and the Birmingham Central Technical School.]

### Corozo Nut Waste

London, W.1.

The Editor, *Plastics*.

Dear Sir,—We have been told that you may perhaps give us information where we can buy corozo nut waste, otherwise known as the waste from the ivory nut.

THE HUTCHINGS MNFG. CO., LTD.

[EDITOR'S NOTE.—As this material is widely used for making buttons, we can only suggest circularizing the button manufacturers in this country. We strongly suspect, however, that imports of this have decreased greatly during the war.]

### Parchment Adhesives

Cheltenham.

The Editor, *Plastics*.

Dear Sir,—With regard to your article on "Synthetic Adhesives" in the March and April issues of *Plastics*, we should be very glad if you could recommend the best type of adhesive to use, bearing in mind that the joint is to be immersed in oil, generally Intava Utility Specification D.T.D.44.B. or 44.C. It is essential that the adhesive should be readily obtainable and easy of application. The material we wish to stick together is parchment or similar substance.

It would be very much appreciated, also, if you could give us the name of a supplier.

AIRCRAFT COMPONENTS, LTD.

[EDITOR'S NOTE.—The inquirer does not give sufficient information for a reasonable reply. Parchment may be real parchment or paper treated with acid, oil, etc., and each would entail the use of special adhesives.

On general principles, however, it would seem that a urea-formaldehyde cold-setting glue would be best. British Industrial Plastics, Ltd., and Aero Research, Ltd., sell this type. Plybond (Bakelite, Ltd.) or Tego glue film might be suitable if heating and pressure can be applied and if the parchment will stand up to the temperature. Again, the cellulose nitrate films withstand oil fairly well. You might be interested in the extremely ingenious process of Cellon, Ltd., of Richmond, who make an adhesive for joining metal to metal by first applying the adhesive to each sheet, allowing to harden before adhesion is made and then ironing both sheets together under heat. The interlayers of thermo-plastic are thus welded together. The parchment would have to withstand 120 degrees C. to apply the process.

Finally, you may not need the plastic type of glue at all. "Parchment" paper can be stuck very efficiently with animal glue in which about one per cent. of potassium dichromate or chrome alum has been dissolved. This would be oil resistant, although not bacteria resistant. The plastic glues are much superior in this latter respect.]

# PRODUCTION

**Practical Information dealing with Raw Materials, Moulding and Forming of all types of Plastics—Thermo-Hardening and Thermo-Plastic—Works-Organization, New Plant and Control Apparatus**

# NOTES AND COMMENTS

## Petroleum Bricks

DURING a recent address to the Oil Industries Club, Dr. A. E. Dunstan, chief chemist to the Anglo-Iranian Oil Co., gave his hearers a remarkable picture of the advances made in the applications of petroleum chemistry and the building up of new substances from simple chemical bricks. For us his most interesting words dealt with the production of plastics from the treatment of petroleum gases.

For example, from ethylene gas by simple polymerization we can produce motor spirit, but in the presence of a catalyst that ethylene can be converted into a material of extraordinary high molecular weight, up to a range of 100,000, and these materials obtained by the prolonged polymerization of the chemical bricks are substances akin to rubber. In addition, both formaldehyde and phenol can be produced from petroleum, the former as the first product of oxidation of methane and phenol from hydrocarbon pyrolysis.

Dr. A. E. Dunstan proceeded to elaborate, in lighter vein, a scheme of things to come. "I picture a man," he said, "in this petroleum age, rising in the morning. He lives in a very beautiful plastic house with hollow bricks and no windows—the whole thing is translucent. He goes down to his bath, which, of course, is again in plastics, and heated, say, with liquid butane or something of that sort. Of course, being a petroleum man, he would have artificial teeth which are also made of plastic material, and he sees that they have been properly disinfected with antiseptics produced from petroleum phenols, etc. Then he goes down to his breakfast, previously dressing himself in a suit of plastic thread material. Of course, you can get that to-day. You can get nylon, which is a very convenient plastic. Our petroleum man dresses himself in a suit of such material dyed by petroleum dyestuffs to suit his æsthetic taste, and he goes down to feed. It is perfectly clear, of course, that at breakfast he will eat synthetic starch and sugar. You can start with formaldehyde, water and magnesium, and make a perfectly excellent sugar, and a little bit farther on you get starch. After breakfast he goes to his synthetic roof where there is a helicopter using a high octane fuel. Two c.c. will take him to his office, and there he finds himself surrounded with telephones, desks, cabinets, etc., all made from the same petroleum plastics. It is quite conceivable that at 11 o'clock in the morning he may feel thirsty, and there again he can have his synthetic alcohol, made from ethylene, of course, with a tincture made from a delightful compound which gives the stuff adequate flavour. Then the time may come when this poor man will be involved in a war and when explosives, poison gases and instruments of death and destruction—all made from petroleum—have done their work, he will be given a petroleum funeral with five gallons of fuel."

## Idle Machines

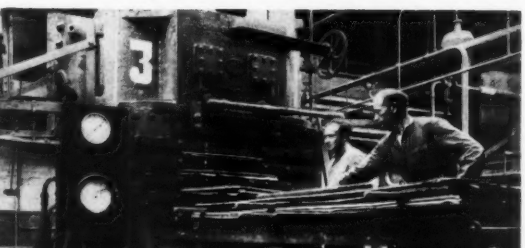
IN a recent issue of *Machine Tool Review*, Sir Alfred Herbert deals with "the scandal of the idle machine" in a manner that should energize the whole country into instant action. He asks us to take stock of our sins and set them forth by way of public confession:—

(1) We have allowed ourselves to be hampered by obsolete peace-time regulations of the Home Office regarding the employment of women and young persons by day and by night. (2) We have failed to realize that there is no available skilled labour and some of us have tried, and are trying by advertising and offering bribes, to induce skilled labour to leave one job where it is usefully employed to move to another where it will do no more to help the national output but only cause disorganization and delay. (3) The Government having power to prohibit such advertisements has failed to exercise that power and it still refuses to face the fact that restrictions on the movement of labour are inevitable. (4) We have not yet realized that much of the work done by skilled labour in peace-time can equally well be performed by semi-skilled and unskilled labour after brief training. (5) We employers have failed to realize that what labour we want we must find from the highways and hedges and train it ourselves to deal with the repetition jobs which it can perfectly well perform. (6) We have not yet found jobs for the million of unemployed who are waiting to come to us. (7) We have not, as we did in the last war, succeeded in attracting thousands of women from other walks of life to come into our workshops—not to mention the butchers and bakers and candlestick makers who must all come in. (8) The Labour Party, though pledged to win the war, has not thrown its full weight into bringing about a complete acceptance of the temporary relaxation of the outworn privileges which are an effective bar to real progress in war-time. (9) We have allowed ourselves to rest content while more than half of the machinery already available in the country stands idle at night, although by a united effort all this machinery with its invaluable tools and equipment could be run continuously.

# PULP, PAPER AND PLASTICS (Contd.)

By Julius Grant, M.Sc., Ph.D., F.I.C.

*In our May issue Dr. Grant discussed the nature and manufacture of paper and pulp preparatory to describing their processing with plastics. He deals in this issue with impregnation by means of synthetic resins and the laminated products produced therefrom. In a subsequent issue he will describe surface-coated products, fibrous fillers for plastics and the treatment of paper pulp with plastics.*



Steps in the production of laminated products at the works of Bakelite, Ltd. The photographs show (1) treatment of paper with resins; (2) consolidation of several sheets in a press and (3) the finished laminated material.

### (1) Laminated Products

ALL methods of this kind have in common two main operations, namely, first the impregnation of the paper with the fluid or semi-fluid plastic, and, secondly, the treatment of the impregnated paper in such a way that the plastic sets. As a rule, although by no means always (see below), the plastic is applied in the wet state, usually as a solution in a volatile solvent. The method of application by this so-called "wet" process varies considerably according to the nature of the plastic and the purpose for which the finished product is intended; as a rule, however, the principle of one or other of the usual methods of "after-treatment" of paper is adopted, as these enable the paper to be used in reel-form, thus ensuring continuity of operation.

In one method the paper is led by rolls under the surface of the solution in a vat. Adjustable press-rolls or doctor blades serve to remove the excess of liquid so that the requisite degree of impregnation is obtained. In another modification of the process the principle of the ordinary varnishing machine is used, that is to say, the paper passes between two rolls, one of which is fed with a solution of the plastic, which is thereby applied to the surface of the paper as a thin film. The method of feeding may be by means of a small trough, having an exit at the base and placed so that the solution is distributed over the top roll; this necessitates a relatively viscous solution. The quantity applied is controlled by the size of the opening, by the clearance between the rolls, or by a doctor blade. An alternative is a reservoir of solution in which the lower portion of the bottom roll rotates, the amount of plastic transferred again being controlled as already indicated.

It will be seen that such methods allow considerable flexibility as regards the amount of plastic which may be transferred to the paper, and in some instances this degree of control may be increased by making adjustments in such conditions as the temperature, concentration or viscosity of the solvent used (cf. F. W. Skirrow, *Chem. and Ind.*, 1938, 57, 117). Such control methods are very useful when adapting the impregnation process to differing types of paper. It has been stated in fact (see H. Carlson, *Tech. Assoc. Papers*, 1939, 290) that resin contents which vary from 15 to 70 per cent. (calculated on the finished material) are obtainable.

The drying operation which follows is also continuous and is performed by heat, the paper being passed through a chamber at 100 degrees to 140 degrees C. at a rate which varies according to circumstances; as a rule the paper is not in the chamber for less than one minute or more than seven minutes. The heating medium is steam coils, or preferably a current of conditioned hot air. On occasion very slow evaporation of the solvent is desirable, in which event the temperature may not exceed 80 degrees C. This is an important part of the process, as the rate of drying must be carefully adapted

to the nature and quantity of plastic used. This is achieved by controlling both the rate of travel and the temperature, and cognizance must be taken of three important factors, namely: (a) If drying is too severe the subsequent moulding operation may be affected. (b) If drying occurs too rapidly trouble may arise from the changes in dimensions which the paper undergoes; as these are much greater across the direction of the reel than in the direction of the reel, unequal strains may be set up, which result in warping. In this connection it is sometimes important to distinguish between ordinary drying and conditioning. If such strains are to be minimized, the mere removal of solvent may not be sufficient; the treated paper must finally be exposed to air at a controlled temperature and humidity until the dimensional changes are complete and the internal strains are dissipated. (c) If the resin is inadequately dried the combined effects of heat and pressure during the subsequent moulding operation may extrude it out of the paper again. With formaldehyde-urea plastics the final moisture content should be 3 to 5 per cent.

As a rule, from this stage the process ceases to be continuous. If a laminated product is being made the paper is cut into sheets of suitable size, and a pile consisting of the requisite number of such sheets between a pair of polished plates is placed in the hydraulic laminating press. Chromium-plated or stainless-steel plates are to be preferred, but copper and steel are also used. The highly polished finish of the plates imparts a shiny surface to the final product; or if the plates carry a design (e.g., an ornamental stippling) this also will be transferred to the surface being pressed. The hydraulic press must be capable of maintaining, according to circumstances, a pressure of 750 lb. to the ton per sq. in., and a temperature of 135 degrees to 150 degrees C., for periods which range from a few minutes to five hours, according to the number of sheets undergoing lamination and the type of plastic; thus when these are only few in number the period may be less than half an hour. Control of temperature and pressure, and especially of the former, is of great importance, and provision must, therefore, also be made for cooling the pressing surfaces rapidly after the laminating process is complete by means of cold flowing water. The actual temperature used also depends on the nature of the plastic. Thus the commonest plastics used for lamination in this way are the phenol-formaldehyde and formaldehyde-urea types; the former require a temperature somewhat over 150 degrees C., whilst for the latter a slightly lower temperature suffices. It is usual to carry out this operation in batches of sheets numbering up to 80 at a time, and in some instances the pressure is applied intermittently, with short "breathing" periods.

Attempts have been made to make this part of the process continuous also, and to this end the web of paper is drawn under great tension between pairs of heated rolls under a considerable pressure, and then through a hot chamber. As may be expected, however, this is a less effective method, although there are indications that certain types of plastics may be processed in this way. A similar type of method is used for making tubes and rods, the paper being drawn under tension over a heated mandrel, and brought to the desired external diameter by the action of a heated iron roll operated under great pressure. The desired thickness may also be obtained by using a relatively thin sheet of paper (e.g., 30 to 90 grms. per sq. m.), and rotating the mandrel until the requisite number of layers has been built up; for comparison, it may be mentioned that for the manufacture of flat objects paper of substance 60 to 120 grms. per sq. m. is used. The usual lengths and diameters for tubes, etc., are 4 ft. and 4 in. respectively. Angles and channels, etc., are made in a similar way. One method of making rod follows the above lines, the mandrel used having a very small diameter; if the mandrel is then removed and the tube pressed in the mould, the central hole may be closed up. The manufacture of tubes and rods introduces an interesting problem of a paper-making character. It is apparent that with any article which is much longer than it is wide the directional effect of the grain of the paper will come into play. If the treated paper is wound in its continuous state from a reel around the mandrel, then the majority of the fibres will lay around the circumference of the article; this means that the most absorbent edge of the paper is exposed to the air, with the result that the moisture resistance of the finished article is impaired. The trouble can be overcome by using paper in sheet form, so that the winding may take place in the other direction, but this has the drawback of discontinuity of operation.

Generally speaking, such methods are restricted to the manufacture of material in sheet form, in circular or angular, open or closed tubes or channels, and in rods of circular or angular sections. As is well known, however, these are themselves capable of being transformed by cutting, shaping and working into a multitude of further different products; they may be threaded, and it is on record (see T. H. Gant, *Chem. and Ind.*, 1938, 57, 263) that even such a structurally complicated piece of plant as a centrifugal pump, complete with impeller, has been made from a phenol-formaldehyde laminated plastic; this has a high degree of resistance to attack by salts, acids, organic solvents, and fatty substances.

It is not proposed to discuss in detail in this article the properties and numerous uses of laminated plastics of this type, as these will be already familiar to most readers of *Plastics*. It is appropriate, however, to summarize some of their features in comparison with those of other plastics in which paper is used, although in a somewhat different capacity, because these laminated plastics have been described as in many respects a closer approach to the ideal structural engineering material than any other plastic product. In the first place, they are obtainable in a convenient form for further processing, and, unlike moulded plastics, no special moulds are required, an important cost factor. On the other hand, there are limitations to the surface areas of single sheets which can conveniently be made in one piece.

H. W. Rowell (*Chem. and Ind.*, 1934, 53, 24) gives some interesting numerical comparisons of strength, which show that these laminated plastics (phenolic type) are considerably stronger than the best powder mouldings containing wood fillings. Thus tensile strengths (in lb. per sq. in.) are recorded of 5,000 to 8,000 for powder mouldings containing a fibrous base, and 9,000 to 18,000 for laminated plastics (made from paper or fabric), as compared with 20,000 to 35,000 for grey cast iron and 9,000 to 15,000 for ash wood. Corresponding figures for cracking-compression are 26,000 to 35,000, 30,000 to 45,000, 70,000 to 95,000, and 9,000 (vertical grain) respectively. It is interesting to note that laminated products made by coating paper with the plastic are, if anything, somewhat stronger than those obtained when impregnated paper is used, but that they have much higher powers of water absorption; incidentally, the moisture-absorbing property of powder mouldings is very low, although, as already pointed out, this property depends largely on

the nature of the cut edge of the article, since most of the absorption takes place here.

From the paper-making point of view an important feature of laminated plastic products is the exacting demands they make on the quality of the paper. The factors which control the absorbency of the paper towards plastics have already been outlined, but, though important, this requirement is only one of a number. Most workers on the subject sum up all such requirements in that of uniformity, and this applies irrespective of the type of paper used or of the purpose for which the finished article is required. It is apparent that to make adjustments for variations in the character of the paper during a run of impregnation and lamination is difficult, if not impossible, because no warning is given of changes in the character of the paper as the reel unwinds. This demand for uniformity applies particularly to properties such as substance (i.e., weight per unit area) and thickness (which, taken together, control the final finish of the paper), strength, porosity and, of course absorbency. Suggested tolerances for these properties (cf. J. G. Abel, loc.cit.) are ± 5 per cent. for substance and ± 10 per cent. for thickness and strength.

Considerable emphasis is also given to uniformity in the sense of absence of foreign material, and especially particles or lumps of unbeaten or undigested pulp and metallic particles. In general the effect of these is enhanced in the final product, so that what was originally a very small spot may eventually spoil a large and costly panel from the decorative point of view. Since many of these laminated products are used for electrical parts, and must therefore have high insulating properties, the presence of metallic particles is particularly objectionable, and for similar reasons such papers must be as nearly neutral in reaction as possible. Since the impregnating process, up to a point at any rate, is continuous, reeling should be as near perfect as possible, i.e., tears, holes and slack or tight places which might run into wrinkles, etc., must be absent, and there should be a minimum of joins.

As already pointed out, the main considerations which control the selection of paper for impregnation and lamination are the absorbency and strength obtainable for a given cost; good rag papers satisfy all but the last of these, and are used for high-grade work where cost is a minor consideration. Next in order of preference are the pulps or papers containing a high proportion of α-cellulose ("alpha-pulps"), and kraft papers; the outstanding properties of these are absorbency and strength, respectively, and they are used accordingly. As might be expected, the latter is important where rod or tubing is built up by rolling from a web of paper under a high tension. Printed or coloured papers are used with transparent or translucent plastics to produce coloured panels or designs (e.g., wood-grainings are photographed on the surface).

### (2) Impregnated Products

Most of what has been written in connection with laminated products applies also to impregnated materials. Both are, in fact, produced in the same way, impregnated products being cured in single sheets, whilst laminated are dealt with in several layers. The final sheets, therefore, are usually relatively thin, but they have quite a number of uses, especially in the electrical industries, as they can be made with quite high insulating powers. Sometimes, however, thicker sheets of paper and even pulp sheets are used for impregnation (the latter being processed, as a rule, in sheet form), and in this way thicker articles are obtainable.

Another interesting point of difference between laminated and impregnated paper plastics is the nature and variety of the plastics used. The phenol-formaldehyde and formaldehyde-urea plastics are most commonly encountered in the former type, but in the latter not only these but a number of others are to be found. An example is hot ester gum (rosin ester) or its glycol, which is used for the production of cheaper grades of floor-cloth, and of lamp-shades; and another is the coumarone type of resin, which is often used with a cooked drying oil and is very resistant to attack by chemicals.

The alkyd-resins provide another interesting group, the heat-stable type (e.g., produced from phthalic or succinic acid, and an ethylene glycol) being particularly suitable for hot-impregnation, as the resulting product is flexible, and retains its colour and water-resistance on ageing or if heated. The paper is merely drawn through the molten resin, the excess being removed by doctor blades or squeeze-rolls; sometimes the surface is given a final wash with carbon tetrachloride. Those alkyd resins which are affected by heat are less conveniently used, and a solution (e.g., in acetone) is usually necessary. Processes of this kind render papers more transparent (e.g., as in window-envelopes), and novel decorative effects may be produced by adding substances which crystallize in characteristic designs as the solvent in which they are dissolved evaporates. Another novel application is the use of impregnated tissue papers as an adhesive for wood veneers.

*(To be continued)*

### Glass and Plastics

A rare combination of these constructional materials is seen in a new type of perfume bottle sold by Champrel Inc., of U.S.A., and recently described by *Modern Plastics*. It is a two-cavity bottle moulded of glass, carrying different perfumes, with two cast resin stoppers of Catalin. As will be seen from the accompanying photograph, the deeply "cut" bottles are matched in design by the resin stoppers. That phenolic resin has been chosen for such delicate oils speaks well for the recent improvements in these plastics.

# TRADE AND PERSONAL NOTES

**British Titan Products Co., Ltd.,** wishes to advise users of "Kronos" titanium oxide and "Kronos" titanium white that the war in Norway will cause no interference with the production or supply of these pigments. It is well known that since the commencement of their manufacture at Billingham in 1934, "Kronos" titanium pigments have been made from Norwegian ilmenite ore. The German invasion of Norway makes further supplies from this source uncertain, but there are large stocks of ilmenite at the factory and ample supplies are available from other sources, notably India.

**Mr. P. A. Richards** has now taken over the control of Plastics (Pty.), Ltd., on behalf of Associated Engineers Co., Ltd. The address of Mr. Richards is now Aeco House, Corner of Miller and Eight Streets, New Doornfontein, South Africa.

**Barnet Comb Co., Ltd.,** announces that its present address is Welwyn Garden City, Hertfordshire, and the telephone number is Welwyn Garden City 911.

**Forbes Plastic Mouldings, Ltd.,** has changed its name to Derwent Mouldings, Ltd. The address is unchanged.

**The Management Library,** 1, Doughty Street, London, W.C.1, informs us that, in order to help business firms speed up the training of their war-time replacement staff, it has compiled sets of technical text books and business training manuals. Intended for the guidance and quick instruction of rank-and-file employees and newly appointed junior executives, the books are practical and go straight to the point of their subjects. The courses cover office routine and office management, factory administration and foremanship, salesmanship, retail selling and branch shop management.

**The Monsanto Chemical Co.,** U.S.A., has approved plans for an expansion of the activities of the company in Australia. Establishment of facilities at Melbourne for the manufacture of many fine chemicals will be started at once.

**Durez Plastics and Chemicals, Inc.,** North Tonawanda, N.Y., U.S.A., announces an addition to its new 1900 Black Series of phenolic moulding compounds, to be known as Durez 1905 Black. This material is said to have an impact strength of 0.6 (A.S.T.M.) and heat resistance of 418 degrees F. Unusually good gloss for high impact compounds is reported with this material. It is available only in the new particle size which is especially designed for free flowing through feeders and hoppers to simplify the production of preforms. Due to the high bulk factor of this series, deeper preform cavities are required; otherwise thin preforms will result.

**The Charles Davison Branch** of General Refractories, Ltd., Genefax House, Sheffield, 10, has just published a new catalogue dealing with Davison heat and acid-proof materials.

**The National Savings Committee** is organizing a National Savings Week from June 9 to June 15. The object is not so much to raise a large sum of new money during the week, but to increase the number of Savings Groups. Of these there are already over 80,000. By June 15 it is hoped to achieve at least 100,000. Closely allied to this main object is the desire to increase the membership of existing groups and to increase the amounts of the weekly subscriptions to them paid by members.

Of the Savings Groups formed since last November, 75 per cent. are in places of employment. The action of the Government in exempting from various Means Tests £375 worth of new savings has drawn from the Trade Union Congress a declaration and a broadcast urging all Trade Unionists to support the voluntary savings movement. Organized employers have given assurances that proof of the workers' capacity to save shall not prejudice future wage negotiations. It is hoped that these assurances will result in a strong stimulation of Savings Groups in all industries and trades.

Employers who have not yet formed groups or given facilities for their formation should place themselves in touch with the National Savings Committee, Sanctuary Buildings, 20, Great Smith Street, Westminster, S.W.1.

**Bull Motors, Ltd.,** has now opened an office at 8, Waterloo Street, Birmingham, 2; telephone number, Midland 6660. It is the purpose of this office to provide for service facilities, quotations and technical information to all customers in the Midlands. Attention is drawn to the exceptionally good deliveries given of standard A.C. motors. As a direct result of the completion of the new factory prior to the outbreak of war, production has been substantially increased and the company is in a position to dispatch many of the more popular sizes and types of standard A.C. motors from stock.

**Newman Industries, Ltd.,** Yate, Bristol, has sent us some interesting details regarding its totally enclosed motors. We are publishing a full account of these in the July issue of *Plastics*.

**President of the Institution of the Rubber Industry** presented the Colwyn Medals for 1940 to Dr. Philip Schidrowitz and Dr. Henry P. Stevens on May 22 for their scientific contributions to the knowledge of rubber. The report of the council and the balance-sheet and statement of accounts for the year ended August 31, 1939, were adopted at the 18th annual general meeting, held before the presentation.

**Hannifin Manufacturing Co.,** 621-631, South Kolmar Avenue, Chicago, Illinois, U.S.A., has just introduced a new hydraulic press designed especially for moulding. The press, built like a machine tool, provides rapid operation, with simple control, in a compact self-contained installation. Standard design hydraulic presses of this type are available in capacities of 125-300 tons, with or without motor-driven hydraulic power units.

**Hercules Powder Co.,** Wilmington, Del, has just issued new technical data summarizing the latest information on ethyl cellulose and a study of its properties and possible uses.

**"Casein and Its Uses,"** by Hans Hadert, has just been published by the Chemical Publishing Co., Inc., 148, N. Lafayette Street, New York, N.Y., U.S.A., at three dollars. The book gives details of the various methods of obtaining casein from milk and the advantages of each method. Following this are the sections on casein, glues and paints. Numerous formulæ are given and technical problems are discussed exhaustively.

**"The Soybean Industry,"** by Dr. A. A. Horvath, published by the Chemical Publishing Co., Inc., 148, N. Lafayette Street, New York, U.S.A., at four dollars, is a useful addition to the library now being built up on this subject. Methods of soybean processing are given in detail and also the most important industrial uses of soybean products.

**Viscose Development Co., Ltd.,** showed a net profit for 1939 of £21,268, a considerable increase over that of the previous year, which was £10,877. The distribution on ordinary shares was 10 per cent., and £3,000 was placed to reserve. The deduction for tax was £9,000, and a sum of £999 was carried forward.

# NEW MATERIALS—NEW PLANT—NEW METHODS

## Diamond Steel Cutters and Saws

In the working of laminated sheet and mouldings of both thermo-setting and thermo-plastic materials the question of suitable tools is often a very great problem to manufacturers. This can, however, be largely solved by the proper selection of tools designed for the actual job in hand and in this case the use of J.K.O. Diamond Steel Cutters and Saws is worthy of consideration, as they are finding many new applications in the plastics industry. These are specially designed for use with plywood, blockwood, laminated boards, ebonite and phenolic mouldings, castings as well as thermo-plastic sheet, rod and tube. The advantages claimed by the manufacturers are as follows:—

1. Theoretically correct cutting angles for each individual cutter type and diameter. The proper clearance of the teeth, making burning impossible.
2. Hours of machine stops eliminated owing to the long life of J.K.O. cutters before resharpening becomes necessary, and, of course, hours of grinding time saved.
3. Greatly reduced wear and tear on the machines owing to effortless cutting and shearing action of cutter teeth, minimizing resistance, eliminating "hitting" and reducing friction considerably.
4. Big reduction of load on motors, with resultant saving in power consumption.
5. Considerable time is saved by using solid type cutters. No individual setting of knives, profiles always correct. No jointing.
6. Complete safety from danger of teeth flying off. This is always a possibility with separate knives bolted into a block.

It is interesting to note that J.K.O. Cutters Ltd., of Bush House, Aldwych, W.C.2, is at present experimenting with a new fast production milling machine for use on plastic materials, which, when fitted with Diamond Steel Cutters, should prove a very interesting proposition.

## Vacuum-type Applicator for Pliofilm

Anticipating stretch-wrap application of Pliofilm to powdered, granular and even liquid substances, the Goodyear Tire and Rubber Co., Akron, Ohio, has developed a vacuum-type applicator which will work equally well with solid articles. Principle of the new device in operation is as follows: A sheet of Pliofilm is held in place over the aperture of a metal chamber of the desired size, open at the top. An arrangement of outlets connected with a pipe circuit permits exhaustion of air from the metal chamber. Pliofilm sheet is heated and exhaustion of air from the chamber causes the sheet to expand from the pull of the partial vacuum and fit against the contour of the chamber's walls. Material to be packaged then is poured into the pre-shaped package, which is heat sealed by twisting the opening prior to release of the edges of the sheet for removal from the machine.

## Portable Pneumatic Conveyors

Pneumatic conveying has in recent years found a wide number of applications in the transport of chemical powders and similar materials, and also for the easy collection of dust from grinding and similar machinery. Most of these installations have been restricted to a specific duty and are in consequence limited to handling materials from one part of the works only. Our illustration shows a plant which has been developed recently by Davidson and Co., Ltd., to fulfil the demand for a portable unit with a high standard of performance. In principle its construction is similar to fixed plants.

The unit is mounted on a wheeled chassis provided with castor steering and drag handle to permit of easy haulage. It comprises a rotary exhauster of the constant displacement type, a small electric or petrol motor, a large receiver, a multi-sleeve air filter, filter cleaning mechanism and carriers for the flexible suction hose, nozzles and extension equipment. The receiver has an automatically controlled discharge valve for delivering material into sacks or other suitable containers and thus eliminates delay involved through stopping the plant to dispose of accumulated matter. A 40-ft. length of flexible suction hose with quick-action coupling is provided in convenient lengths as well as extension tubes and alternative types of suction nozzles to facilitate collection from different locations. Additional lengths of suction tube can, of course, be utilized for specific purposes. The capacity of the plant varies from one to five tons.

Close-up of the Davidson portable pneumatic conveyor.

### Synchronous Motors

We have just received a brochure from the General Electric Company, U.S.A., dealing with synchronous motors and control for part-winding starting. This type of equipment is particularly suitable for installations wherein controllable low starting currents are especially desirable. Part-winding starting, as the name implies, consists of starting a motor on part of the complete stator winding. The winding must be of the multiple-circuit type. When starting, one or more of these circuits are first connected to the power supply. Subsequently, the remaining circuits are energized in one or more steps. The result is to reduce the starting current and starting torque of the motor.

The most obvious advantage of part-winding starting, as compared with any type of reduced-voltage starting, lies in the simplification of the control equipment. No voltage reducing device, such as an autotransformer, a reactor, or a resistor is required. Although the motor itself is special and more costly than a standard motor, it is essentially no more complicated. Hence the equipment as a whole ranks second to full-voltage starting as far as simplicity is concerned.

### Flamenol Reduced in Price

A price reduction of approximately 10 per cent. on Flamenol wire, the second reduction in nine months, was announced in April by General Electric's Wire and Cable Division. Since 1937, more than 50,000,000 feet of Flamenol have been sold.